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BULLETIN NO. 2 F.D. 29

1921.

Western Australia.

Forests Department.

Notes on the Forests and Forest Products and Industries of Western Australia.

Second and Enlarged Edition.

Issued under the authority of
THE HON. JOHN SCADDAN, M.L.A.,
Minister for Forests.

C. E. LANE-POOLE,
Conservator of Forests.

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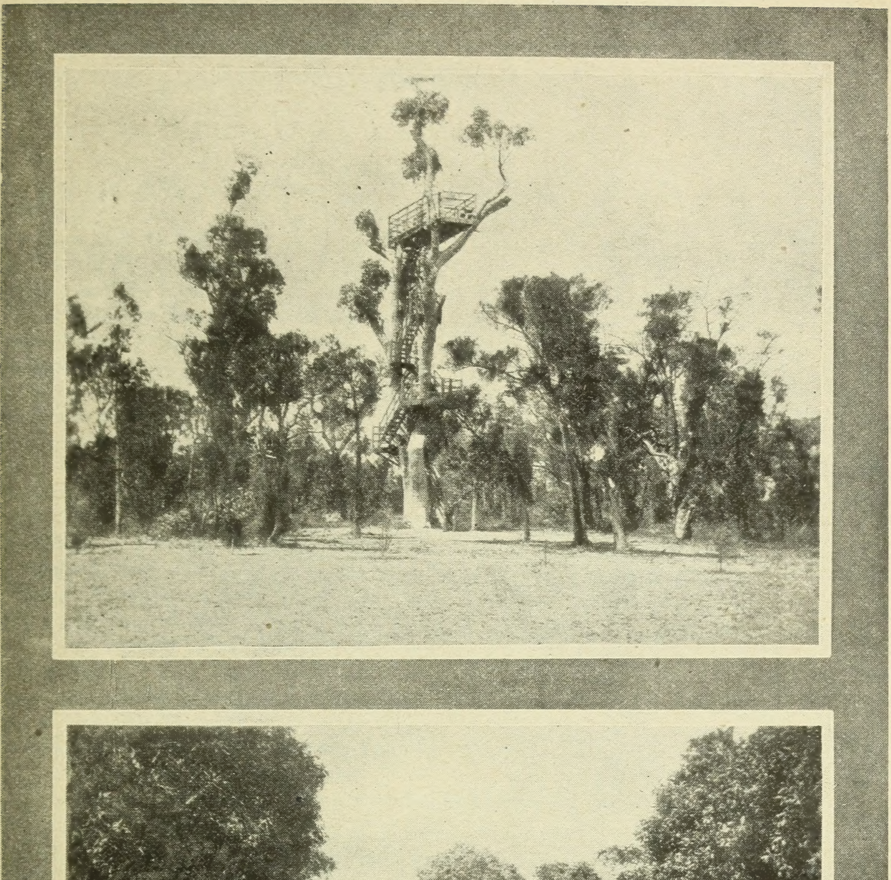

In King's Park, Perth.

Upper: The Look-out.
Lower: Red Flowering Gums, Main Drive.

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FOREWORD TO FIRST EDITION.

The purpose of this pamphlet is to present in popular form a series of short pen pictures of forestry objects. The forests of Western Australia, beyond a shadow of doubt, form the State's largest and most valuable visible asset, and this asset has a quality which belongs to few of its other natural sources of wealth. The forests are inexhaustible if properly managed. The gold from the mining field cannot be replaced, and, once exhausted, what has been at one time a scene of busy industry, lapses into waste. The forests, however, under capable management may continue to yield their riches in perpetuity. In the past our forests have been treated with a recklessness almost wanton ; they have been destroyed, and no attempt has been made to replace the lost wealth.

In these pages many phases of forest problems are touched upon, the whole object being to inform the people of the State exactly regarding the extent and nature of their forest heritage, to point out that, as the forests have been of inestimable economic value in the State's progress, so they deserve kindly consideration at the hands of the people. If these pages assist in arousing in the minds of the Western Australian public a consciousness of the intimate relationship that exists between the State's economic progress and its forests, they will have served their purpose. The Forests Department is now engaged in the work of regenerating cut-out areas and repairing the havoc of the past, and its work will be infinitely assisted if those at the head of affairs know that behind them they have the strong support of an united public opinion. That this support will be given I do not doubt. The facts for forming such opinion will be found in these pages, and those who read them will, I feel certain, be impressed not only with the supreme value of the forests to the State, but interested in the romance that has attended one of the State's great primary industries.

J. SCADDAN,
Minister for Forests.

June, 1920.

PREFACE TO SECOND EDITION.

The public appreciation of the First Edition of this publication was such that the Edition was rapidly exhausted. In the present issue much new matter has been added, and the whole of the old matter has been revised and brought up to date. The book, as now presented, surveys in a popular manner almost the whole of the wide field contemplated by modern forestry, and should be of use to the many citizens who take an active interest in the State's great natural heritage, its preservation and development. A perusal of it will be sufficient to convince the most casual reader that the forests of the country play a larger and more important part in the national life than is commonly suspected or understood.

J. SCADDAN,
Minister for Forests.

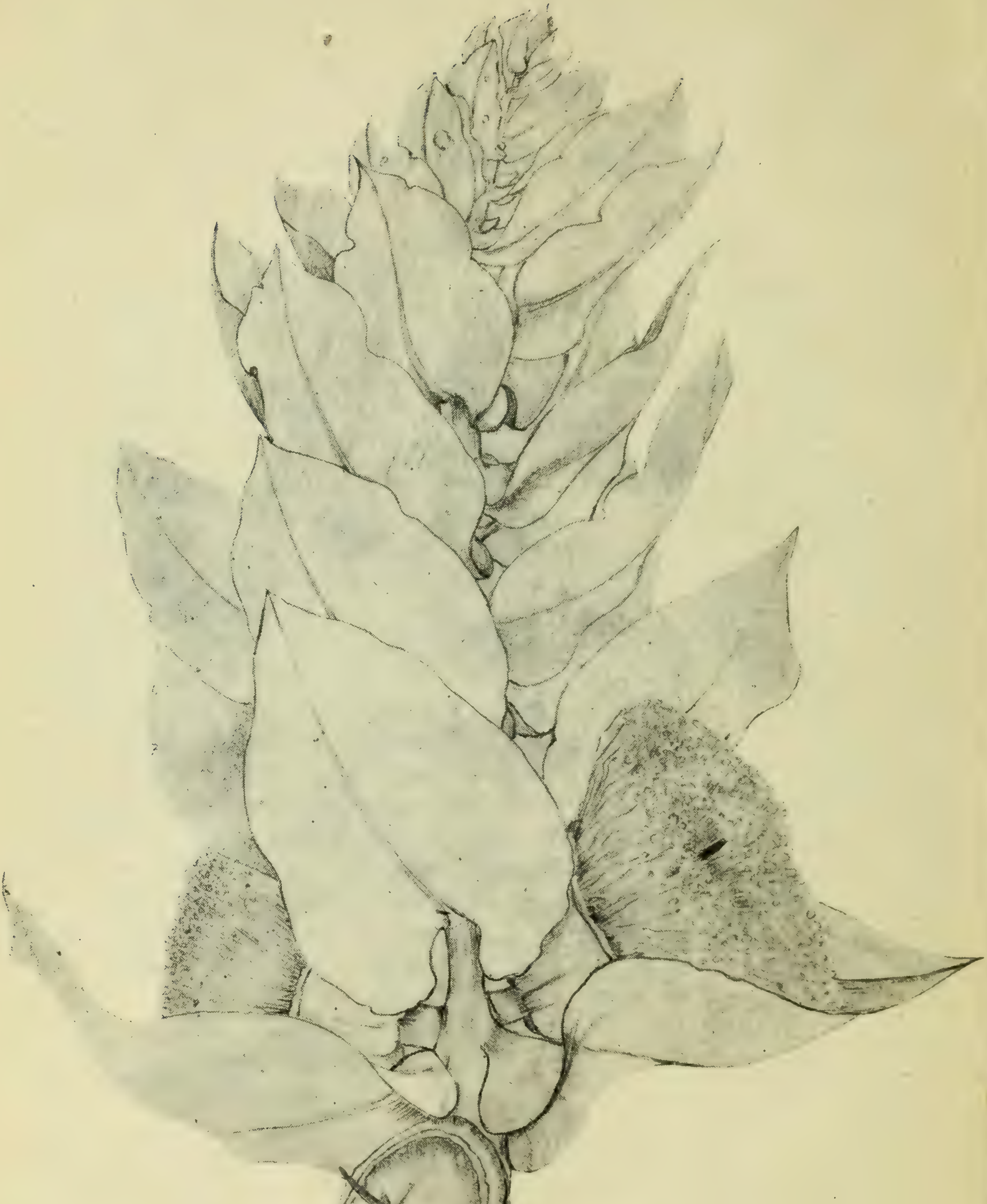
June, 1921.

INTRODUCTORY NOTE.

The purpose of this publication is to bring before the public of Western Australia some facts and figures connected with the State's forests and their possibilities not generally known. It is unfortunate, perhaps, that a juster appreciation of the part which the forests play in the State's economic welfare has not in the past been realised to a degree that the matter undoubtedly deserves. Several old and erroneous but prevalent ideas touching our forests must in the light of modern conditions be jettisoned and replaced by sounder notions. The fallacy that our forests are inexhaustible is dying slowly—too slowly indeed for the forests well-being—and the equally erroneous belief that a fire through a forest does good must also be replaced by a juster and truer view. Again, it is held commonly that the production of timber is the be all and end all of forest capabilities. A perusal of the following pages will, it is hoped, be sufficient to dispel this entirely inadequate conception. What possible sources of wealth our forests contain we are only now beginning to realise, but, aided by such investigations as those that may be undertaken by a forest products laboratory, the wealth and employment-giving potentialities of the forests will be brought into clearer perspective and will stand out with that definiteness which compels conviction. It is trusted that this publication, prepared for popular use, will lead to increased interest in forest questions on the part of the public and to increased realisation of the value to the State of its great timber heritage.

C. E. LANE-POOLE,
Conservator of Forests.

June, 1921.

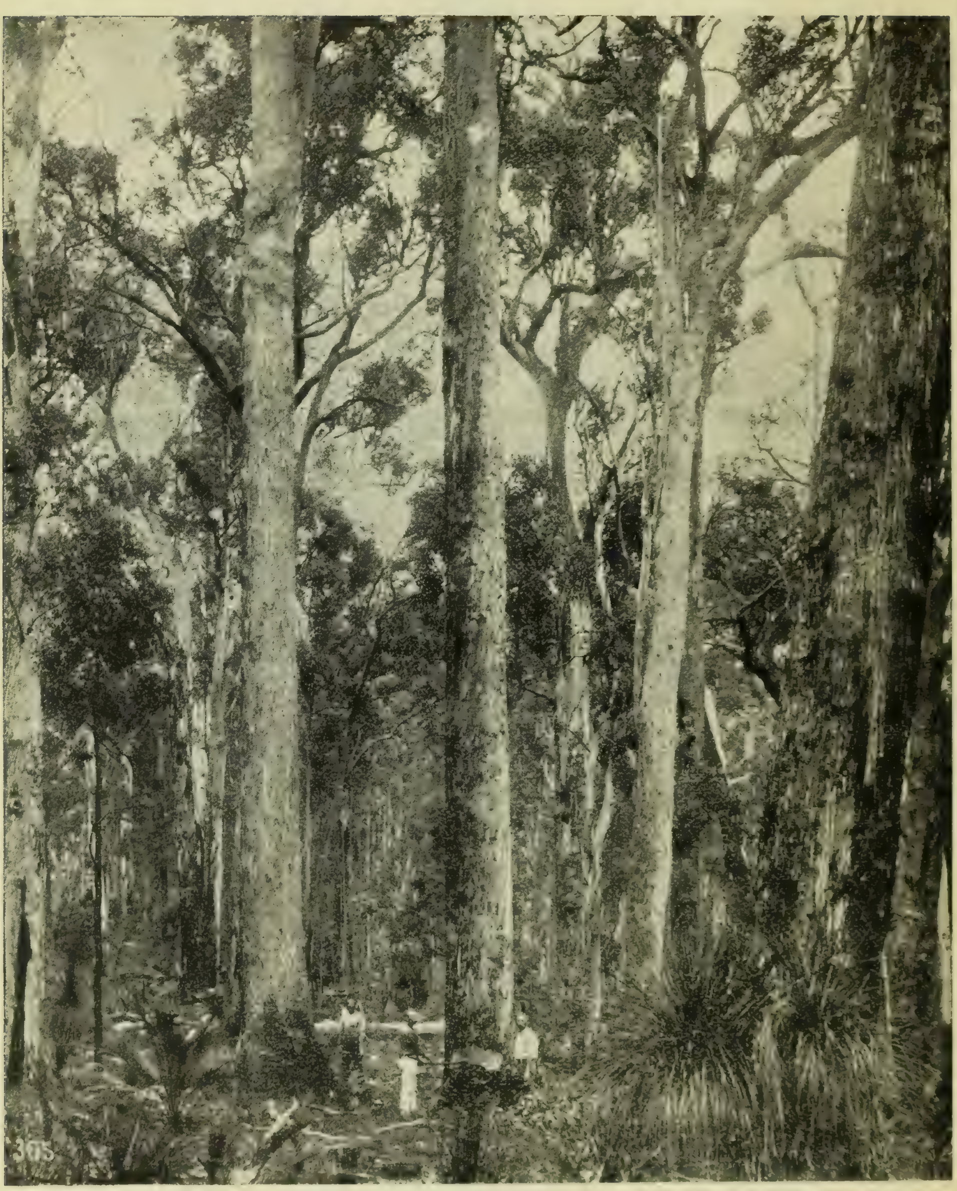

RUTH LANE POOLE
JUNE 1916

"Rose of the West."
W.A. Bluegum.

The *Significance* of Forests.

Of the many forms which a nation's national heritage may take, there is none so valuable as forests. Precious stones and metals may bring riches, but, exhausted, they cannot be replaced. No art of man can induce nature to reproduce mineral wealth that has been removed. But forests, unless wantonly destroyed, may go on reproducing themselves for ever—a never failing source of wealth and an ever present asset to the community possessing them. In the forest, for the mere trouble of reaping, we find a material which fills more human requirements, meets more human necessities than any other. Nature has been generous to Western Australia, and in the great jarrah and karri forests the pioneer white men found stored the accumulated wealth of centuries. Natural forest resources possess an important element which is absent from other of nature's gifts. They are capable of yielding increased returns to increased activity. In other words, man by the exercise of care and skill can induce a natural forest to produce more abundantly than it does in a virgin and uncultivated state. Upon this provision of bountiful nature, the science of forestry is founded. Look all round, form judgments on all that is seen, and ask is there any material which is more often and more intimately connected with man's welfare than wood? There can be one answer only. There is no such material. Wood is more than necessary for men's comfortable existence through life. Without it life would be unendurable. Without forests man could never have emerged from primitive barbarism. He must have for ever remained a cave-dweller. Without timber he could have crossed no great stream, nor traversed the ocean. He would have been condemned for ever to entire ignorance of the lands and peoples beyond the seas which washed his own shores.

But the significance of forests as factors in human development is not limited to the raw timber derived from them, and the numberless functions it is capable of fulfilling. With the advance of civilisation, and the increasing demands for suitable materials for meeting new wants,



Jarrah Forest.

the latent possibilities of wood began to be tested, and the results of these tests have been as marvellous as they have been satisfactory. Under distillation new products of wood have been brought to light, all of them of value in arts and manufactures. To-day many avenues of employment and of wealth are dependent wholly upon substances derived from wood. Under distillation wood yields pyroligneous acid, charcoal, gas, tar, and many other substances of prime value to man in his commercial relations. From this it is possible to form some conception of the importance of the part played by wood in all industries dependent, wholly or partly, on chemical products.

The following eloquent tribute to the value of trees is taken from the "Forest Club Annual" of the University of Washington :—

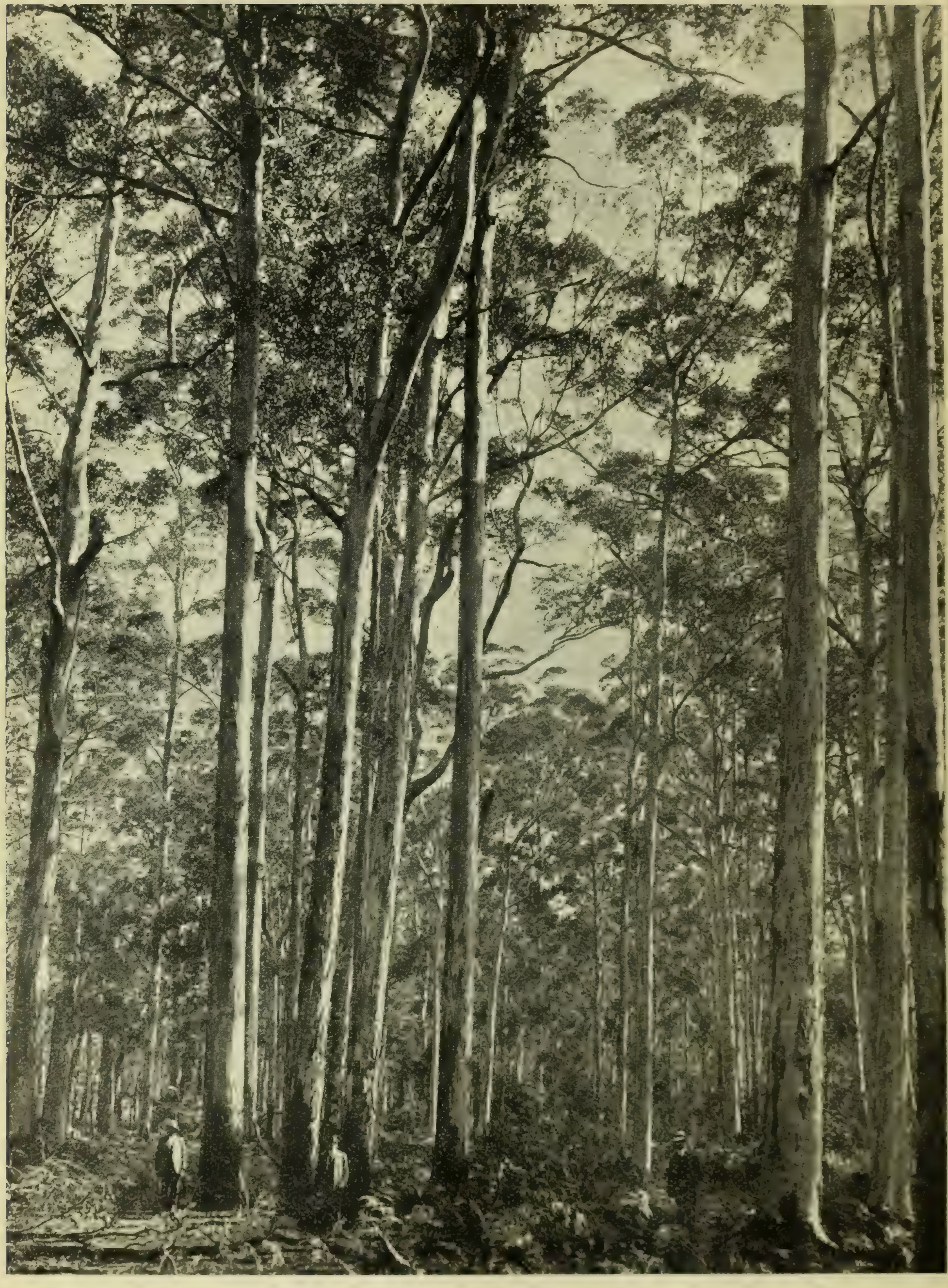
"Trees are the arms of Mother Earth lifted up in worship of her Maker. Where they are, Beauty dwells ; where they are not, the land is ugly, though it be rich, for its richness is but greasy fatness and its gaudy raiment is but cheap imitation of forest finery.

"Trees are the shelter of men and beast and bird ; they furnish the roof above us, the shade about us, and the nesting places of love and song. They call children out to play ; they entice sweethearts into leafy coverts to seal their vows with fond caresses ; they console and gratefully reward old age. They are the fittest ornaments of wealth and the inalienable possessions of the poor who can enjoy them without having title to them. They are the masts that fly the flags of all nations and the sails of all the seas ; they are the timbers that bridge forbidding streams ; they bear the wires of the world's intelligence ; they hold the rails that carry the traffic of the continents ; they are the carved and polished furnishings of the home ; they cradle the young, and coffin the dead.

"Trees are nature's prime sources of food ; their fruits and nuts gave sustenance to the first tribes of men, and are the sweetest and most nourishing of the earth's products.

"Trees herald the spring with glorious banners of leaf and bloom ; they clothe the autumn in garments of gold and royal purple ; bared to the winter's cold, they are the harp of the winds, and they whisper the music of the infinite spaces.

"Before the earth could be peopled it was set thick with trees ; and when man has run his course and the race we know has disappeared in the completeness of its mission or perishes in the destruction of its trees, the earth will spring up again with new forests to shelter and sustain a new race of men and beasts and birds to work out a greater destiny. Perhaps if we are wise enough to replenish our wasting forests and to make ourselves worthy of the gift of trees, we may be permitted to accomplish that greater destiny which the Mighty Forester, the Perfect Orchardist, the Loving Father requires in the fulfilment of His sublime purpose."



Karri Forest.

FORESTRY A SCIENCE.

Forestry is a science and, without unduly straining language, it may be asserted that it is a science that, so far as the British Empire is concerned, has been lost and rediscovered. When England was dependent wholly upon her own forests for the timber with which to build her ships and, in great part, her houses, and to fill the many uses in industry to which wood is put, her forests were managed with skill. Their protection against unwise destruction, the cutting of the timber, the replanting of cut-over areas were among the duties of those who followed the craft of forestry. The forester in England in those days was a person of some importance, and the value of his services to the community was fully recognised and fittingly rewarded. But, when England became a commercial nation and her ships traded in every sea, foreign timbers gradually began to be introduced, and the time came when almost the whole of the timber used was imported from abroad. With the rise in importations, the national forests were neglected, much of the best woodland was denuded of timber, and the land given over to grazing and other purposes, and forestry lore was neglected, and the ancient and honourable craft of forestry fell on evil days.

For something like two centuries England has depended upon foreign countries for her timber supplies, but the disastrous experiences arising out of the war have demonstrated the folly of such a course, and to-day the British Government is actively engaged in fostering the reforesting of every suitable acre that is not required for food-raising or other essential purpose. In other words, scientific and economic forestry is being reborn in England. In these days the significance of the word "forest" has come to mean any woodland area that has become an object of care, with a view to its protection against wanton destruction, and its management so that its productive capacity may be maintained and increased. The treatment of forests on sound rational and scientific principles, so that the best financial and economic results may be got from them, constitutes the science of forestry.

The Science of Forestry is based on sylviculture which differs essentially from arboriculture. Sylviculture, or forest crop production in its widest sense, may be defined as the application of knowledge regarding the life history of trees to the practical task of growing them. And the forester must not only know the general features of the biology of the species, their development from seed to maturity, and their requirements as to soil and moisture, but, as he is producing something for revenue, he must also take cognisance of the amount of production and the rate at which that production takes place. Arboriculture may be said to be the growing of trees for any purpose not primarily financial or economic. The arboriculturist considers the aesthetic value of trees in city gardens or streets or pleasure reserves, or as game coverts, or for any other purpose in which timber production for sale is not the main element. The differences between sylviculture and arboriculture are analogous to those existing between agriculture and horticulture. The forester—the man engaged in the work of scientific forestry—must of necessity have a wide knowledge not only of sylviculture and arboriculture, but of those sciences which deal with the physical properties of soils and forest botany, geology, and entomology. He must be familiar with the principles controlling the relationship between forest climate and production, and he must have made a study of the physical properties of timber. A forester's scientific training and his assimilation of the basic principles of sound forestry enable him to develop positive methods in the treatment and preparation of forests. And to the technical capabilities necessary to the successful application of the science of forestry, a forester must add the business knowledge requisite to administer the financial and economic interests involved in his calling.

FOREST CAPITAL AND FOREST INTEREST.

The " capital " of a forest may be defined as the total amount of marketable timber it contains ; the " interest " is the total annual growth of the trees ; in other words, the percentage by which they increase in volume. In a forest in which a large proportion of the trees are mature or over-mature, the ratio of annual growth is relatively small ; in the case of a forest which contains a large proportion of young and immature trees, the ratio of annual growth is relatively large. In a " natural " forest, that is a forest which has received little or no attention at the hands of a skilled forester, the annual growth is much less than is the case in a " cultivated " forest. In a " natural " forest there are to be found many imperfect trees—mis-shapen, fire-damaged, or otherwise defective and incapable of developing into trees suitable for milling purposes. In a " cultivated" forest all these imperfect trees would have to be removed, and the space they occupied filled with trees capable of developing into marketable timber. Forest cultivation, therefore, increases the yield of timber ; in other words, increases the annual interest on the forest capital.

Eucalypts native to Australia have been introduced with remarkable success into other countries, and in all of these countries the annual rate of growth is greater than in Australia. The reason for this lies on the surface. Wherever the eucalypt has been planted abroad it has been carefully " cultivated." Imperfect trees have been weeded out as soon as their imperfections have become visible, and nothing that does not give promise of yielding first-class timber on maturity has been allowed to remain. In India, South Africa, and California great attention has been paid to the growing of eucalypts. Writing of eucalypt cultivation in its report for the year 1912–13, the Board of Scientific Advice for India says :—

> "The figures collected in the plantations of the Nilgiris show some astonishing results in the rate of growth of *eucalyptus globulus* (bluegum). Many annual increments of 527 cubic feet per acre and of 815 cubic feet in the case of seven-year old coppice show that this species uses the productive qualities of the soil to the extent of forming, in the case of coppice, over 16 tons avoirdupois of wood in one year per acre."

In South Africa karri has shown a yield of 400 to 500 cubic feet per acre per annum, and that country is now taking £26,000 annually out of the thinnings of her plantations. Speaking on this subject in the Legislative Council on the 5th December, 1919, the Hon. John Nicholson said :—

> "It has been demonstrated that karri land without any expenditure of money whatever, with no care or forestry treatment, will grow this valuable timber at the rate of 100 cubic feet per acre per year. The age of maturity of the species has not yet been ascertained, but it may be put down at a maximum of 100 years. We may, therefore, expect without any expense of sylvicultural operation 100 x 100, or 10,000 cubic feet of timber (200 loads) to the acre at maturity. Much more than this has actually been cut from an acre by the State saw mills at Pemberton on virgin forests, so that 10,000 cubic feet may be regarded as a moderate estimate for an even aged stand of karri. This is the country that has been given to the settler at £1 8s. per acre. With proper forest management the rate of growth will be far higher than 100 cubic feet per acre."

Sir D. E. Hutchins, a forester of world-wide reputation, and author of "A Discussion on Australian Forestry," writes :—

> "Yields Compared—Cultivated and Wild Forests.—The wild forest is usually characterised by very heavy yields of timber over certain areas, but with a much lower useful and general yield. Some of the record yields of timber from virgin forests are astonishing—up to 100,000 cubic feet per acre in the case of Redwood and certain patches of heavily stocked Coniferous forest. The Douglas-pine (*Pseudotsuga douglassii*) has perhaps the heaviest stock over any large area ; but the general position is that the cultivated forest is much more productive than the wild forest. It is the main part of the science of modern forestry to so regulate the cuttings that the forest undergoes a gradual and continual improvement. Statistics show that the yield from many of the cultivated forests of Europe has doubled during the last half-century. Careful statistics showed that the Prussian forest doubled in value between the years 1850 and 1890."

FOREST POLICY.

From what has been said about the scope and objects of forestry and the work of a forester, it becomes evident that the management of woodland resources must be carried on in accordance with a fixed plan if the best is to be made of them. In every large business or undertaking method must be evolved and prevail throughout the whole of the operations. The work of the forester from its very nature calls for a system, the continuity of which must not be disturbed. The forester has to take long views, for a century may lapse between the sowing of the seed and the reaping of the mature tree. Briefly put, the object of laying down a fixed system of forest management and exploitation—a forest policy—is to conduct the business of the forest in a way that will ensure to future generations a sufficient supply of timber. In conducting their operations the sawmiller and others have a definite object in view—that of getting as much timber as they can in the shortest possible time. They remove the best and most desirable trees, leaving the inferior, badly grown or mis-shapen trees still standing. Such a course, if continued, leads to a change in the composition and quality of the trees, the forest is deteriorated in value, and its future productiveness impaired. Improvident misuse of any natural resources is a matter which calls for interference or regulation by the State in the interests alike of its present revenue and of the future. In every civilised country this interference takes the form of a department whose duty it is to see that wise measures of exploitation are adopted and carried out. There are several ways in which the State can beneficially exercise its regulating and protecting powers for the public good. In a country such as Australia, where the people are the real rulers, the Government—the people's representatives and executive—must find its most effective aid to protecting national wealth in such educative measures as shall convince all that ill-advised use of a natural resource must inevitably lead to its destruction. When once a free community has become seized of the fact that its own interests are intimately bound up in the conservation of a natural resource, that resource will no longer be misused, for the people themselves will insist upon the adoption of adequate measures for the safeguarding of their property.

Such a policy of conservation is an urgent necessity for Western Australia, for ever since the foundation of the Colony the forests have been cut down, with no thought for future requirements. The timber industry has always held a foremost place in the State's activities. It gives employment to thousands, and is the solid basis of a comfortable existence for tens of thousands. If the forests are to continue to be a national asset of the first rank, work in them must be conducted in such a way that only the crop they annually yield must be annually reaped. And the only effective way for the attainment of the condition aimed at by the administration is the adoption of a policy of conservation with a regulated exploitation, and the single object of getting the best out of the forests for the welfare of the people of the State now and to come. Such a policy would necessarily include :—

The classification of the land with a view to the demarkation and survey of the forest estate.

The permanent reservation of this estate.

The appointment of a certain number of highly trained officers to draw up the plans necessary for the management of the forests.

The establishment of one sound forest school for the training of the professional staff.

The training of a subordinate staff in the practice of forestry.

The establishment of a Forest Products Laboratory to investigate the commercial possibilities of our wealth of forest produce.

The initiation of a wide publicity campaign in order to awake a forest conscience in the minds of the people.

Generations ago the increase in the cutting of the native forests created some public alarm, and a gallant effort was made to stem the tide of destruction and to introduce a policy which would conserve the forests. Speaking on this matter in the House in September, 1918, Mr. R. T. Robinson, K.C., Minister for Forests, said :—

> "The Government of that day appointed a skilled and expert forester, Mr. Ednie Brown, to advise as to what course should be adopted. Unfortunately for Western Australia, Mr. Brown died very soon after his arrival in the State, and the Government that appointed him went out of office. Before Mr. Brown died, however, he managed to awaken in the public a sense of their duty, and he drafted a Forests Bill, a Bill which differed very little from the one now placed before hon. members. Had that Bill become law I feel sure that the management of the forests of the State would have been placed on a sound foundation. Alas ! with Mr. Brown's death died also the Forests Bill, and the country once more threatened to sink back into a slough of apathy regarding forestry. A small band of men who had been associated with Mr. Brown in his work and had learned from him something of his ideals, and of the theory and practice of forestry, strove hard to keep alive the spark of enthusiasm which he had kindled, and they so far succeeded that in 1903 a Royal Commission on Forestry was appointed to investigate the whole subject. I will have occasion to read many recommendations from that Commission. This is what the Commission had to say about the appointment of an expert forester :—" Evidence afforded by the experience of other countries, as well as that of this State (as indicated by evidence given before the Commission) seems to prove most emphatically that no forest conservation worthy of the name is practicable until the forest lands shall have been placed by Statute under the control of a well-manned and properly equipped Forests Department.' And later, in the second portion of their report, the Commissioners say :—' The evidence attached hereto supplies much information on the questions raised in this second

reference to the Commission, all of which has strengthened the opinion of the Commission as to the utter impossibility of making adequate provision for conserving the forest interests until they shall have been placed under the administration of an Inspector General qualified by experience and scientific training.' This is what the Commission recommended regarding the Advisory Board:— 'Realising, however, a possible delay in obtaining an officer qualified to fill the important position of Inspector General, the Commission is of opinion that no time should be lost in securing the legislation necessary to put the administration under the effective control of a board as suggested. Such a Board would find ample occupation in establishing some degree of order out of the present destructive chaos, preparatory to the appointment of an Inspector General.' "

Nothing came of the Commission's recommendations, and the position gradually got worse and worse until public opinion again forced the hand of the Administration, with the result that a trained forester was appointed in 1916 to take care of the national forest resources. The task in front of the new Conservator is a difficult one, and will require energy and enthusiasm to evolve forestry order out of forestry chaos. "The Forests Act, of 1918," referred to elsewhere, provides him with certain powers, and these he is exercising to the fullest extent. It will be years before the effect of the administration can be seen, for the forester pre-eminently has to take long views, but, with public opinion behind the Forests Department, there can be no doubt as to the result. There must inevitably arise a period during which there will be partial stagnation of forestry activity. There are still in existence old contracts covering hundreds of thousands of acres, and many permits also covering large areas. When these contracts have expired the export trade in jarrah will practically die, until a new crop has grown. Western Australia has been a timber spendthrift and, like all spendthrifts, a time must arise when there must be a cessation of spending and a husbanding of resources in creation of fresh wealth.

FOREST ADMINISTRATION.

The world of the present day is widely and deeply deploring the short-sightedness and apathy of past generations in respect of forestry matters. A world shortage of timber is threatened, and those nations which have not already done so are hastening to adopt measures for the protection of what remains of their forest, for the regeneration of despoiled areas and for planting new ones. From the inauguration of Western Australia in 1829 until the end of 1918, the vast forest heritage of the State was, to all intents and purposes, at the disposal of any who cared to make use of it. For many years no restrictions at all were placed upon cutting. After the lapse of more than a generation certain regulations were brought into force, but these had reference only to revenue, and no attempt was made to reforest cut-out areas nor to regulate exploitation. It was not till the year named that the forests were administered under certain clauses attached to the Land Act. In December, 1918, a Forests Act was put upon the Statute Book "to provide for the better management and protection of forests." The following is a brief summary of its provisions :—

Part I. is preliminary, and deals with interpretation, repeal of previous authority, preservation of existing rights, and powers to extend.

Part II. incorporates the Forests Department and the appointment of officers, the Conservator being declared to be a corporate body. The qualifications, training, and duties of officers are also defined.

Part III. deals with State forests and timber reserves. It provides for classification and dedication of forests, the purchase and resumption and exchange of land, reservation of timber reserves.

Part IV. deals with permits, licenses, and forest leases and royalty.

Part V. has reference to financial provisions. Three-fifths of the net revenue of the department, to be certified by the Under Treasurer, is in every financial year to be placed to the credit of a special account at the Treasury, and is to form a fund for the improvement and reforestation of State forests and the development of forestry.

Part VI. deals with regulations, which may be made by the Governor on the recommendation of the Conservator.

Part VII. is devoted to offences, penalties, and general provisions. In this part it is provided "a day shall be set apart in every year for the planting of trees in the several land divisions of the State, and such day shall be called 'Arbor Day.'"

The forest "Working Plans," on which the continuity, and incidentally, the whole future of the forests depend, are laid down by the Conservator, and, having been approved, cannot be altered except on the recommendation of the Conservator. Under the planting provisions of the Forest Act the Parliament of Western Australia has wisely introduced clauses designed at once to assist the farmer, and by so doing to extend the State's production of timber on alienated land. It is provided that—"On the disposal of land under the conditional purchase provisions of 'The Land Act, 1898,' it shall be a condition that the purchaser shall use an area of not less than two per centum of the acreage of the holding acquired by him for the growth of timber or other forest produce," and in a subsequent subsection it is declared that "the planting of trees on not less than five acres of any such land shall be deemed an mprovement within the meaning of the Act."

FORESTRY AND EMPLOYMENT.

The forests of Western Australia in normal times give employment to over 5,000 men working in various capacities in the mills and in the bush on behalf of the mills. Outside of this there are employed directly in the forests only the officers attached to the Forests Department, but under a scientific system of forestry the woodlands of the State would find constant employment for a very much larger number of men. According to a return prepared in South Australia from official reports, the number of persons employed by the Forestry Departments of the various States in the Commonwealth in 1910 was 220, and this figure includes office staffs. It does not strike one as extravagant, and even if it has increased by 50 per cent. since 1910—which is very doubtful—the total is still absurdly small compared with the interests involved. But the extremely attenuated numbers forming Australia's official forest workers are in keeping with the general public attitude in the Commonwealth in regard to forestry questions. They reflect the common apathy which exists in the matter of the care and preservation of the national forest wealth. We have to look around in order to acquire some knowledge of the part that properly managed forests may play in the economics of labour.

In Belgium, prior to the war, the total area of State forests was only 430,000 acres, yet employment was given to 32,000 workers in winter and to 750 all the year round. In Germany, in the winter months, the average labour employed in the Bavarian forests is one man to 40 acres, and, taking all the year round, one man to 130 acres. The whole State forests of Germany total 35,000,000 acres, on which 1,250,000 people live directly, and 3,750,000 live on industries dependent on the products of the forests.

Such instances might be multiplied, but sufficient have been adduced to support the contention that properly managed forest areas absorb a very large amount of labour. An expert, who examined the forests of Australia two or three years ago, in his report on the labour question put the matter thus :—" Perhaps the worst error in the history of Australian colonisation has been allowing good forests to be destroyed for sheep-grazing. A reliable estimate of the employment on a sheep station gives one man for every 7,500 sheep, or, perhaps, as an average for forest lands, one man for every 7,500 acres ; while ordinary forestry, when systematically practised, gives employment throughout the year at the rate of one man per 800 acres. So that, approximately, forestry gives ten times the employment that sheep do. And yet this squandering of the public estate, this reckless loss of rural employment still continues !" Most public work must be done when it is wanted, but there is always a store of forest work that can be hastened or postponed with little inconvenience. That is a question for the forest "working plans" and the forest officers who are carrying them out.

Outside the question of the vast regular employment which a forest, under proper control, can provide, and beyond the rural population attracted by dependent industries, there is the unemployed problem, which becomes more or less acute from time to time. Australia has its unemployed. Says the *Age* (Melbourne) on 29th March, 1915, in an article on State Forestry :—"Thousands of pounds have been spent to provide the unemployed with work of such little value that they might almost as well have been engaged carrying bricks up a ladder in order to carry them down again, yet here is profitable work for thousands. In this fine undertaking (forestry), as well as for the planting of exotic timbers, the State wants, first of all, direct and independent control, a Forestry Department free from political influence, managed by an expert who has the knowledge of a skilled forester."

Another difficult problem which an intelligent system of forest management would go a long way to solve is that of rural depopulation. This is admittedly one of the great social problems of the day, and one which is yearly increasing in intensity. It is not confined to any one country, but seems to be common to most where industrial undertakings are conducted on a large scale. Those countries without forests, or with only woodlands of small extent, do not possess a potential means of relief which exists in those more bountifully supplied with natural timber resources. Australia is happily endowed in this respect. In every one of the States, forestry places it in the power of the Government to do something definite towards keeping people in the rural district. The opening up of the country, by the organisation of the forests, and the considerable expenditure in so doing, would also be a powerful assistance to many of the struggling agriculturists in the forest regions.

It is evident, therefore, that from the standpoint of national economy, every productive employment of labour, directly or indirectly concerned, is of great moment. Forestry is the twin-sister of agriculture, and it is often attempted to make comparisons between them in national economic value. Such comparisons must always be in the nature of doubtful estimates. Everything depends on the degree of intensity which has been applied to the particular industry. It would be unfair to compare, for labour-absorbing statistics, an area of agricultural land, intensely cultivated, with the like area of virgin forest. Agriculture certainly directly employs more labour than forestry, but economically the forest still more than holds its own. An American forestry professor crystallises the point thus :—"If forest affords only one dollar per acre in labour earnings, it also gives rise to a labour-earning of over three dollars per acre in wood-working industries."

Scientifically organised, forestry pays the State in every way. It yields a handsome profit on the annual output, and it goes a long way to check abnormal concentration of population in the capitals, and in it the unemployed may find productive labour.

FORESTS AND CLIMATE.

The question of the influence of forests upon climate has engaged attention from the earliest times. Even as early as the Roman days it was recognised that too great a clearing of woodland areas brought undesirable changes in the physical conditions of Italy, and affected the welfare of the inhabitants adversely. The time was when Sicily was well wooded. It was then the granary of Rome. Its woods were cut down, and its productiveness was so seriously reduced that it scarcely produced enough for the use of its own inhabitants. Cyprus is another instance of the evils which follow unwise deforestation. Early in the 19th century vast woods in the French Alps in the Southern portion of France were cut down. The results were disastrous. A few years after their destruction the Agricultural Society of Marseilles reported that, in consequence of the reckless destruction of the forests after the Revolution—" the winters are colder, the summers hotter, and the beneficial spring and autumn showers no longer fall. The Uveaune, flowing from East to West, rushes down in flood with the least rain, carrying away its banks and flooding the richest pastures, while for nine months of the year its bed lies dry owing to the drying up of the stream."

The deductions from these facts are obvious. Authorities of the highest order give the conclusions that they have arrived at in no uncertain manner. De Humboldt, in his great work " Kosmos," refers to the influence of forests in lowering the temperature of the whole surrounding region. He ascribes the reason to the following :—

1. The canopy formed by the crowns prevents the heating of the soil by direct sun's rays.
2. The evaporation of moisture by the leaves.
3. Night radiation resulting from the wide extent of surface made up by the foliage.

Investigation by competent observers has shown that the total quantity of moisture returned into the atmosphere from a forest by transpiration and evaporation from the trees and the soil is about 75 per cent. of the precipitation. For other forms of vegetation it is about the same, or sometimes larger, varying between 70 per cent. and 90 per cent. Scientific investigation into the question has received greater attention in France than in any other country, and the results arrived at point unmistakably to the fact that forests not only equalise temperature and increase precipitation, but by holding up a large percentage of the rainfall and giving it off gradually, cause rivers and streams to flow with a nearly equal volume at all seasons of the year, whereas, in a country that has been devastated rainfall, as was the case in the Landes, would take the form of rushing and destructive streams followed by long periods of dry watercourses.

The temperature of the air in a forest being lower than the surrounding country, it is natural that more condensation takes place. To prove this, M. Mathieu in 1866 established three research meteorological stations—

1. In the centre of Foret de Haye, area 14,000 acres, there is a clearing known as "Cinq Tranchue," where the forester's house is situated. Here one rain gauge was erected. Adjacent to this, but in a 40-year old dense stand of beach and hornbeam, a second rain gauge was erected. Now, in a dense forest, the amount of water reaching the gauge depends on the amount of opening in the leaves above it. To eliminate all errors a gauge was made having the same large surface as the crown of a selected tree, and this was built around the tree itself.

2. The second station was chosen at Bellefontein on the edge of the Foret de Haye. Here another rain gauge of ordinary construction, but of very large dimensions, was established.

3. Finally a third station was established at Amance in purely agricultural country.

All three stations were within 10 kilometers of Nancy and at the same altitude.

Records were kept from 1866 to 1882, when it was found necessary, for some reason, to move the Amance station to Champenaux. The following table explains itself :—

Total rain recorded from 1867–1899 in mm.—

Station 1—28006·1 mm.

Station 2—26295·4 mm.

Station 3—21470·3 mm.

Average fall per year—
Station 1—848·7 mm.
Station 2—796·8 mm.
Station 3—650·6 mm.

Expressed as a percentage—
Station 1—100.
Station 2—93·9.
Station 3—76·7.

It will be seen that more rain falls within and in the neighbourhood of a forest than in bare country. The records for each year bear this out. M. Mathieu's experiments at Nancy have been repeated in pine forests, oak forests, in Germany, and in Switzerland, and they have all resulted in the same conclusions.

Springs are affected by the infiltration of rain. Rain falls on the earth, percolates through, and either finds its way out as in hilly regions in the form of springs, or dams itself up in subterranean lakes. Do forests increase the flow of springs ? From time immemorial the answer has been "Yes." Buffon, writing in 1730, said—"The more a country is denuded of timber, the poorer does it get in water." The French Forest Law of 1827 lays it down that the forest officials must oppose the destruction of forests so that the springs and rivers may be protected. A wide study of the question points to the following conclusions :—First, that where forests exist larger quantities of water reach the soil than in places that are bare ; and second, that the proportion of water which, having reached the soil, is allowed to reach the subterranean water level is greatest in forested country.

The conclusions on the whole matter which have been reached by investigators may be summed up as follows :—

1. Forests increase the rainfall. This is proved beyond doubt, in spite of the fact that many persons still continue to deny it. It amounts to 23 per cent. increase, and this is a mean of 33 years records at Nancy.
2. The forests retain some of the rain in the branches and leaves. Against this, however, the crowns condense more water, being colder. So that the forest soil receives more water than bare country.
3. Forests diminish the evaporation from the surface of the soil to an enormous extent, and also hold up the run off. So that in hilly and mountainous country the forests increase the subterranean waters enormously.

4. As far as we know at present forests do not, however, increase the supply of subterranean water in plain or level country. In fact it would seem that the trees, as opposed to grass or other shallow-rooted crops, take up more water from the soil, and so lower the general level of subterranean waters. The question is not finally settled, and many contradictory results have been arrived at.

5. We must remember that springs are only numerous and big in the hills, and that the forest most certainly increases and maintains them through the dry season. In plain country springs are rare and of little importance, so that we may say as the old French foresters did, that forests are the mothers of rivers.

In the South-West of Western Australia the whole water supply depends on the springs in the Darling Range, and the conservation of the forests in the catchment areas is the duty of every good citizen. If this is not done the run off from the hills during the winter will increase the torrential characteristics of the streams, and in the summer the streams will become detached pools. People visit Mundaring Weir to see what has been calculated at 300,000,000 gallons of water going to waste. Were the catchment area under dense forests that immense run-off would be held up late into the summer, so that the weir would remain full all the year. A past and foolish Government destroyed the forests of the catchment area. They argued that what happens in the plains will happen in the hills. Let us hope they have learnt a lesson.

Summing up a discussion on the co-relation of forests and moisture precipitation, Dr. James Brown in his work, "The Forester," says :—

> "From a consideration of these facts it appears evident that, within certain limits, of course, by the distribution of plantations of such extent as may be suited to the particular circumstances of each case, it may be in the power of man to modify certain local climatic conditions so as best to suit the various kinds of crops he cultivates in different localities."

From what has been said it is evident that Western Australia, in the interest of her farmers, as well as of forest workers, must preserve every acre possible of forested country, and must regenerate cut-over areas as well as engage in planting of suitable areas with other varieties of trees than those indigenous to the country.

FORESTS AND STREAM FLOW.

Some Recent Investigations.

The evidence in support of the contention that forests exercise a distinct and beneficial influence upon stream flow and springs is gradually accumulating, and it seems that what was at one time little more than an unproved theroem is assuming the status of an ascertained and well proven fact. The theory has in the past been seriously disputed, or has been accorded only a tentative and guarded acceptance. But a careful examination of the conclusions, and the reasons for arriving at them, of those who declined to commit themselves to definite acceptance, makes it clear that most of the dissentients had arrived at a decision from a consideration of purely local conditions and had not made themselves fully conversant with the results of long and careful observation elsewhere. Strangely enough, foresters of the first half of the nineteenth century, few of whom employed methods recognised as sufficient by scientific investigators, were, take them all round, more inclined to adopt the theory that forests do influence climatic conditions and the flow of water than were those of the second half of the century. The modern forester, however, if he does not arrive at a definite standpoint, brings an open mind to bear on the matter and is ready to receive and weigh evidence that is satisfactorily supported. And, speaking broadly, foresters throughout the world at the present time, with few exceptions, admit that forests have very important functions in the matter of precipitation and conservation of water, and they examine eagerly all proofs that are advanced when the observations on which they are based have been conducted on strictly scientific lines.

France, more than a generation ago, conducted an investigation into the matter, and the results, as published, strongly confirmed the view that between forests and precipitation and water-flow, there is an intimate connection. And now the results of another investigation have been made known. In 1900 the Swiss Engineering Station at Zurich undertook an investigation, using two watersheds in the adjacent mountains as the scene of their operations, and making their experiments in accordance with the strictest scientific requirements. The work covered a period of eighteen years, and it will be of interest to state here the deductions from the Swiss observations that seem to be of general application.

One general fact that has been confirmed by the Swiss experiments is that a good forest cover has a very beneficial effect upon the regime of streams in mountains and hilly country. Another fact confirmed was that streams fed from a forested watershed have a more uniform discharge and carry less debris into the larger rivers to which they flow than streams coming from an unforested watershed.

The Swiss experiments have conclusively shown that extensive damage from floods occurs less frequently in streams coming from forested watersheds than from streams rising in poorly forested or treeless watersheds. This is, of course, an absolute guarantee against the power of the elements.

The great importance of forests in hills and mountainous regions in feeding springs has been proved beyond a doubt in the Swiss experiments.

In general rains of variable intensity the forest cover showed a tendency to retard the amount of run-off. It was proved that the porosity and lightness of forest soil is brought about by the protection furnished by the tree crowns, by the formation of leaf mould, and by the presence of living and dead roots and an abundant soil fauna. Forest soil, it was ascertained, is much more permeable to water than unprotected soil. It was deduced from the experiments that the whole explanation of the favourable effect of forest cover upon stream flow lies in the greater porosity and permeability of the forest soil.

The Swiss experiments have discounted the opinion long held by many prominent investigators that the great water-retaining power of the forest soil is due mainly to the great receptive capacity of the leaf litter and moss cover. The experiments have conclusively shown that raw humus and moss cover have had a very unfavourable effect upon the water regime. Many evidences of damage from floods in forested regions could be directly traced to accumulations of raw humus in the forest.

The results of the Swiss experiments are fully embodied in a publication written in German and issued in 1919 in Zurich.

In this connection it should be stated too that, in 1910, a similar project was instituted by the United States Forest Service, in co-operation with the Weather Bureau in the North Rocky Mountains at Wagon Wheel Gap, Colorado. The results of these experiments are not yet published, but are expected to be made known soon, and a comparison of results obtained in Western America with those furnished by the Swiss investigators will be of the highest interest to foresters.

AN ARBORETUM AND ITS VALUE.

An Arboretum, in the sense in which it was originally used in Great Britain, is the name given to that part of a garden or park which is reserved for the growth and display of trees. These trees are arranged usually after some definite method—it may be properties, or uses, or some other principle—but usually after that of natural likeness. The plants are intended to be specimens showing the habit of the tree or shrub, and the collection is essentially an educational one. In modern days the term arboretum has acquired a wider signification, and it may be defined as a tract of land set apart for the experimental cultivation of all kinds of trees, with a view to their introduction to places beyond their native habitat.

Arboriculture and the formation of arboreta were undoubtedly practised at a very early date in the history of civilisation. It was in the nature of things that it was so. When the first hardy mariner with heart of brass and triple steel adventured by sea into parts unknown, he, of a certainty, found himself in contact with a vegetation differing in many respects from that of his native country. The economic value of the new growths would be the first aspect of the matter to interest him, and he would naturally be anxious that the new and luscious fruit of the new land should be transferred to his own. He would, as a result, carry away with him seeds or seedlings of the varieties he fancied, and by experiment it would be ascertained whether they were suitable to a climatic environment such as that of his own country. These early voyagers, in fact, were the first to establish arboreta. The accidental transference, in these dim days of the long past, of trees from one country to another has in modern times assumed the status of a science which is intimately associated with the development and progress of many communities. Solomon, we know, bought from Hiram of Tyre cedar from Lebanon, for use in the Temple, and Nehemiah, the prophet, in 384 B.C., asked Artaxerxes for "a letter unto Asaph, the keeper of the king's forest, that he may give me timber to make beams for the gates of the palace which appertain to the house and for the wall of the city and for the house that I shall enter into." Whether Solomon and Nehemiah, recognising the value of the foreign timbers they desired, made any effort to cultivate them in their own country is uncertain. But of all the nations of antiquity the Romans were the most systematic in their arboricultural efforts, and of this ample proof is to be found in the pages of Pliny. At an early period in their history the Romans experienced the evil effects of the wholesale destruction of forests, and in their work of reparation they employed, besides native trees, many that had been brought from foreign lands and were suitable to the climatic conditions of middle Italy. Nearly all the fruits now grown in Europe owe their introduction to the Romans. Great Britain is under a heavy debt to the Romans in respect of trees. They introduced exotics early in their occupation. To the arboricultural work of the Romans Britain owes the elm, lime, sweet chestnut, poplar and other trees. There is evidence that from the 10th to the 17th centuries many more trees, foreign to England, were introduced. In short, the English woodlands of to-day are very largely occupied by trees not indigenous, but which have been brought from abroad during the passing centuries, and have been acclimatised. In modern times the work of determining what varieties of trees are suitable for cultivation in any given localities is carried on under scientific conditions at arboreta. Prior to 1760 there were in England several nurseries in which observations and experiments were carried on, and at the date named the Arboretum at Kew was established. It has rendered invaluable assistance not only to arboriculture in Great Britain, but to the Overseas Dominions, and to foreign countries. Kew has become the world's authority on all questions relating to vegetable life and growth, and, as time goes on, its work is becoming more and more appreciated. There are several other arboreta in the United Kingdom, all performing useful functions, but none possesses facilities for investigation and determination equal to those of Kew. There are several notable arboreta on the continent of Europe, and in the United States of America the Arnold Arboretum in connection with Harvard University is one of the best equipped in the world. In Australia there exists nothing to which the name arboretum can be rightly applied, but in every State part at least of the work contemplated by arboreta is carried on by the various Forests Departments, or at botanic gardens maintained by the respective governments. The advantages to be derived from the establishment of an arboretum in any country are too obvious to require stressing. The forestry position in Australia has now reached a stage when, in the interests of the future, extensive planting must be undertaken, and in this work the services of a well-equipped and controlled Federal arboretum would be of the greatest value.

FORESTRY AND PUBLIC OPINION.

It is only within recent years that the national and economic value of forests to a country has formed a subject for public discussion. And such discussion hitherto has been almost wholly confined to experts or to citizens gifted with patriotism and vision. The public as a whole has remained apathetic. If in various parts of the Empire (including the Mother Land) steps have, of quite recent times, been taken to improve the forestry conditions, such steps have not been the direct outcome of a conscious public opinion. The war showed up Great Britain's disastrous forest poverty in a light so lurid and threatening that something akin to alarm was created, with the result that Parliament passed a measure for the improvement and extension of the country's forested areas. The British public is singularly slow to see the direction in which its own best interests lie, and understanding of a position that may be pregnant with danger comes only when the danger itself is apparent, even to the least observant. Once before in the history of England has a threatened dearth of timber placed the country in a position which might have led to disaster. During the unfortunate years from the Civil War to the Restoration the great and famous forests of England were a prey to every exploiter. There was no check on cutting, and destruction, in consequence, went on with criminal recklessness. Fortunately at that time the newly founded Royal Society, with a prescience which rendered the country for ever its debtor, dipt into the future, and the result was John Evelyn's "Silva." England was roused to action, and the oaks were planted from which were built the ships that Nelson led to victory at Trafalgar. Britain and the Empire are to-day as economically dependent on timber as the United Kingdom itself was a century or more ago. The only difference between the periods is that, in the earlier instance timber was wanted for the building of wooden walls, while to-day it is essential to the existence of numberless industries. The clarion voice of John Evelyn is wanting in these later days, and the creation of a public conscience on the subject is now left to the experts and to such agencies as Forest Leagues. But the task of instructing public opinion is a long and heavy one, though it is by no means impossible, nor do those who clearly recognise the position despair of success. It is a matter of time and of continuous and persistent effort. In July of 1920 there was held in London the most important meeting, so far as forests and timber supply are concerned, ever convened in the Empire. There assembled in conference at the date named, forestry experts from every part of the Empire, and each of these experts brought with him full particulars of the forest resources and future forest possibilities of the Dominion or State or Possession he represented. The conference, in short, was a great stocktaking of the forest wealth and capabilities of the Empire. The delegates realised that the existing forest resources were inadequate and that it was necessary that planting and regeneration should be vigorously pushed on wherever, within the Empire, exploitation had been carried on to an extent greater than that of the annual forest increment. In no other way could the Empire hope to become, in any sense, self-dependent in the matter of timber. But afforestation and regeneration schemes cannot be carried out without liberal expenditure. The delegates felt that on this point, their proposals would receive the heartiest support of the public, as soon as the position and its real meaning were grasped by the general body of the people. By way of aiding the formation of a sound public opinion, it was decided to found an Empire Forest

Association "to promote public interest in forestry throughout the Empire." This association is now in existence and incorporated by Royal charter, with the King as Patron, the Prince of Wales as President, aud Viscount Novar (Sir Ronald C. Munro-Ferguson) as Chairman. It has a great educational work before it and it cannot fail to strengthen and stimulate the Forest Leagues throughout the Empire. The cause of forestry is emphatically the people's cause. With an enlightened public opinion and a lively public sympathy behind them, the hands of the experts throughout the Empire will be immensely strengthened, and they will be enabled to carry through their plans in a way that, without such stimulus and support, would be impossible. The British people do not as yet realise, as they should do, that the forests are their property and that what is harmful to the forests cannot but be harmful to their own interests. In some countries—France and Germany notably—recognition has come to the people and an active forest conscience is at work. The happy result is that the care of the national forest wealth is regarded as a public duty in which each and all must share. Fires in French forests, which are largely of pine, are rare, for the sole reason that the people realise that preventible forest destruction is a crime against the State, inasmuch as it destroys something of value belonging to the whole of the citizens.

PROTECTING THE PUBLIC HERITAGE.

The theory underlying Governments in democratic communities is that public affairs are administered by the people for the people. In practice it has been found, however, that duly appointed representatives of the people do not always acquit themselves of their responsibilities in accordance with the basic principle of democratic control. They are apt to overlook the interests of the many and to favour the interests of the few. They are inclined, sometimes, to sacrifice the inherent rights of posterity in order to meet and satisfy the demands of the present, and they are not always above serving the political exigency of the moment at the expense of the general welfare. In democratic communities public opinion is really guardian of the public good, but on many questions public opinion is uninstructed and, being uninstructed, is unresponsive at times when it should be virile, active and outspoken.

There is in Australia no question that concerns the country's future prosperity more vitally than that of its forests, and, sad to say, there is none on which public opinion is less instructed or less active.

Among the majority of the people within the Commonwealth the belief is prevalent that the country's forests, if not inexhaustible, are sufficient in area and quality to supply all needs for generations to come, and behind this is the nebulous conception that, as trees grow just as agricultural crops do, fear of a future timber shortage should occasion no anxiety. The complacency of the average citizen of Australia on the matter assumes the character of indifference when he sees all around evidences of huge importations of foreign timbers. Knowing nothing of the present position and future prospects of a sufficient world timber supply, he reaches the conclusion that the full and plenty condition which has prevailed in the past will continue.

The task of enlightening the public as to the real facts of the case is one of much difficulty, and unfortunately those engaged in it are comparatively few and their means of reaching the public are limited and none too effective. In this respect Australia seems to be in a worse position than either Canada or New Zealand. Here we have the Australian Forest League, with a branch in each of the States. Some of these branches, to put it mildly, do not seek the public ear with undue persistency. The little band of friends of the forests forming the executive of each does not succeed in securing that amount of public sympathy which is essential to an effective propaganda. There is a want of co-operation and co-ordination between the branches which seriously diminishes the value of the League. The Victorian branch publishes "The Gum Tree," a little journal of an enviably high quality, but what other forms the propaganda of the branch assumes are not quite clear to outsiders. In Western Australia the branch publishes "Jarrah" and engages in Press propaganda on every opportunity that offers, and it contemplates a campaign locally in the shape of lectures and cinema films, but its efforts are seriously handicapped by the prevailing public apathy on forestry questions. The time seems to have arrived when the branches of the Forest League throughout Australia should jointly and seriously consider what methods ought to be adopted, what measures ought to be taken, for a vigorous educational campaign throughout the whole Commonwealth. Every Forestry Department in Australia is keenly alive to the needs of the situation, and those at the head of the Departments are working strenuously towards the bringing about of a better state of affairs. But the efforts of departmental experts, however able and enthusiastic these experts may be, cannot bear a full fruition unless they are adequately seconded by those in charge of the country's business, i.e., by Ministers and members of Parliament. Experience has shown that the politician is not always a friend of the forests. It may be that he shares the prevailing public indifference, or he may be unfamiliar with the existing situation and, therefore, be unable to grasp its meaning and its lesson. Again, his interests or those of his friends may lie in a direction inimical to forest welfare.

and in such a case the advocacy of a department is of no avail. One of the functions of the Forest League is to afford aid to those who are battling for a clearer recognition by the public of the supreme value of its forests to the nation, and it can exercise this function by heartily supporting the endeavours of the experts. It is just here where the essential difference in methods between the Australian Forest League and the body in Canada with similar objects becomes strikingly apparent. The former displays no particular energy anywhere, beyond the issuing of journals; the latter is remarkable for its perennial vitality and the persistence and force of its appeals. Public opinion in Canada, on forestry questions, has, under systematic educational effort, become fixed and definite. What the forests have done towards the Dominion's development is clearly recognised, and what would happen if the forests were destroyed is clearly understood. The result of this awakening of the public conscience is reflected in the attitude of those in authority towards the Nation's heritage of timbered lands. In every province, active operations for conservation and regeneration and protection are on foot, and there is every prospect that Canadian forests will continue to hold that important place in public economics which has been theirs in the past.

In New Zealand, thanks to the happy conjunction of an enlightened administration and an energetic Forest League, a new and better era is setting in in forest affairs, and steps are being taken to retrace the disastrous path that has been consistently travelled since the earliest days of settlement. In Australia the bulk of the people is still apathetic, and this unfortunate condition is likely to continue unless such agencies as the Forest League bestir themselves. Official experts can do much of their own initiative, but their task would be much easier and their labour much lighter if behind them and supporting them there were an instructed public opinion and an approving public.

FORESTRY AND EMPIRE.

The war had scarcely lasted a month when the question of an adequate supply of timber for military requirements and for essential civil purposes began to arouse grave misgivings. In six months the position had become embarrassing, and for the rest of the war period the Nation's timber necessities reacted seriously, almost disastrously, upon the means of keeping up supplies of food and other essential commodities. For the first time in generations, Great Britain's criminal folly in levelling her forests, and trusting to foreign importations for her timber supplies, was brought home to her Government and people ; for the first time a vision of the calamities that must befall the Empire if, in any future time of national crisis, timber in sufficient quantities was not procurable, was vouchsafed to the authorities and they were stirred to action. The appointment in July, 1916, of a Forestry Sub-committee of the Ministry of Reconstruction was the earliest evidence of official recognition of the dangers inherent in the problem. The Sub-committee's report dealt mainly with the question of reforestation in the United Kingdom, but, at the same time, it suggested that national safety was so intimately connected with an adequate timber supply that the matter was one that belonged to the region of Imperial politics. This suggestion, it would appear, has carried conviction to the proper quarter, for in July, 1920, under the authority of the British Government, a conference was held for the purpose of considering the position of the timber supply in all parts of the Empire, as well as the forest policies in force, or in prospect, and the possibilities of arranging close trade intercourse in wood materials. It was also proposed that out of the Imperial Forestry Conference there should be developed a permanent Bureau of Information on Imperial forestry affairs. The urgency of the need for concerted action on forestry matters, by the Mother Country and the Overseas Dominions is so obvious that argument becomes superfluous, but it may be permitted, by way of illustrating the point, to contrast the Empire's comparative forest-nakedness with the timber wealth of certain other nations, and also to note where, in the Dominions, something is already being attempted to anticipate the Empire Forest Policy that was outlined by the Conference.

The following figures are taken from the Commonwealth Year Book :—

Country.	Total Forest Area.	Percentage of Total area.
	square miles.	
Commonwealth ...	*159,375	5·35
New Zealand ...	26,562	25·63
United Kingdom ...	4,820	3·84
France	36,005	17·58
Germany	54,015	25·90
Austria	37,700	31·66
Hungary	34,750	29·30
Canada	625,000	17·34

* This figure includes all woodlands. The actual area of merchantable forest is in the neighbourhood of 40,000 sq. miles. (v. Forestry Conference, Hobart Report.)

A glance at these figures reveals, amongst other things, the timber-strength of the Central Powers, and it is a permissible deduction from the table that if Germany had not had great forests within her own borders, she could not for long have continued to supply the tremendous demand for timber that her military operations entailed. Had her forested areas been as restricted as those of Great Britain, and also granting her the produce of captured French woods, she, within a short period from the outbreak of war, would have been forced to adopt military tactics involving a less consumption of timber than is necessitated by trench warfare.

Australia's forest area is almost three times that of Germany, but it does not necessarily follow that the annual crop that may be reaped in the Commonwealth is three times that obtainable from German forests. Much of the area tabulated as "forest" in Australia is only sparsely wooded country that cannot be regarded as prime forests, while nearly the whole of the German area is covered with merchantable timber. Everywhere in Australia exploitation of the forest heritage has been conducted with wanton recklessness, and until quite recently years such questions as conservation and regeneration have aroused no sympathy. Attempts by trained and experienced men to bring about a better state of affairs have received scant consideration, and proposed legal enactments intended to protect the forests have too often reached the State Statute Books in so emasculated a condition that they have lost much of their intended effectiveness. The Western Australian Forests Act, passed in December, 1918, is no exception. The most valuable provisions in the Bill—those to restrict reckless and unwise methods of conversion—were whittled down practically to inutility, and interests strongly inimical to the welfare of the forests are allowed to continue their destructive careers. Against all this, however, must be set the cheering fact that the Act specifically sets aside a considerable proportion of the forest revenue for the purpose of repairing the wastage of the past, and for increasing the areas that will in time be covered by a crop of merchantable timber. Of all the States, Western Australia is the only one with a large export timber trade, and the new Act, when its regeneration provisions have borne fruit, will put the export trade upon a sound and lasting footing. In other words, Western Australia has adopted measures which will enable her to play a worthy part in any comprehensive scheme of Imperial Forestry. The world for many decades has been a timber spendthrift. It has been living partly on its forest capital and partly on its forest interest, and not for very much longer can the Empire be permitted to draw upon foreign supplies to the same extent as it has been doing for a century or more. In the light of war experience, it is unnecessary to discuss the value of forests to a nation, nor is argument needed to emphasise the importance of the role played by timber in a time of supreme national danger. Western Australia is now viewing the question from an Imperial standpoint. Her great national forest heritage has been much reduced, but under skilled supervision and an enlightened administration, it will, in time, be restored to its former powers of productiveness. When the policy recently inaugurated comes to full fruition, not only will the Empire have a permanent supply of Western Australia's indigenous hardwoods, for use in time of peace, but there will be a reserve that may safely be drawn upon if dark days should come.

BRITISH EMPIRE FORESTRY CONFERENCE.

The world-wide revival of interest in forestry is symptomatic of the times. It is but a further proof, if any such were needed, that civilised communities all over the world have become seriously impressed with the urgency of protecting their natural heritages and of utilising in the most economically efficient manner the resources at their disposal. The Empire Forestry Conference held recently in London may be regarded as evidence that the seriousness of the timber position has at last secured the attention of the Imperial authorities, and that they were anxious to obtain the advice and co-operation of the Empire's forestry experts in finding a solution for the problem both pressing and difficult. Great Britain has ever been prodigal of her native timbers, and, more particularly, during the past century she has with singular fatuity remained content to rely for her supplies upon foreign countries. Over two hundred and fifty years ago, John Evelyn in his "Sylva" wrote:

> "Since it is certain and demonstrable that all arts and artisans whatsoever must fail and cease if there were no timber and wood in a nation (for he that shall take his pen and begin to set down what art, mystery or trade, belonging any way to human life, could be maintained and exercised without wood, will quickly find that I speak no paradox), I say, when this shall be well considered, it will appear that we had better be without gold than without timber."

This warning and advice passed unheeded through the generations, and not until a bitter war experience had given sharpest point to their meaning was the real significance of Evelyn's words understood. Britain's poverty in native woodlands has for long been a byword and a reproach. Speaking at the opening session of the Conference, Lord Lovat produced some startling figures touching Britain's dependence for timber on supplies from abroad and mostly from countries outside the Empire. He told the assembled experts that the timber imports of the United Kingdom in the year 1918–19 reached the colossal sum of £72,000,000, and that in 1919–20 the figures would probably mount to £90,000,000 or £100,000,000, and he added that the ten million tons of the timber brought in represented tonnage space equal to that required for the whole grain imports and exceeded that required for all other foodstuffs, together with cotton and wool. From figures produced at the Conference it may be gathered that Britain's criminal treatment of her forests came perilously near to creating disaster during the war, and has left her the most sparsely forested country in Europe.

While in Germany prior to the war 25·9 per cent. of the country's total area was forest land, in France 18·2 per cent., in Belgium 17·7 per cent., in Russia 37 per cent., and in Sweden 47·6 per cent., in Great Britain only 4 per cent. of the total area was covered by forests of merchantable timber. If these figures, so far as Britain is concerned are eminently depressing, it is heartening to note that their lesson, enforced by a perilous war experience, has not been lost on the British authorities. They have hastened to repair the errors and neglect of earlier days by passing in the last session of the Imperial Parliament an Act designed to place the United Kingdom in a better position in the scale of forest-owning nations, and the summoning of a Conference of the forestry experts of the Empire may be taken as evidence that the Home authorities have determined to exercise at least advisory functions in regard to the timber supplies and resources of the whole of the Dominions. That the Conference shared the view of the British authorities on this point is evidenced by the fact that the delegates passed a resolution advocating the establishment of an Imperial Forestry Bureau. Such a bureau, it can scarcely be doubted, would be of the greatest value. At the present moment the progress of scientific and economic forestry within the Empire is seriously handicapped, and in some respects fatally impeded by the absence of common and fixed standards. The Conference, it would seem, clearly recognised this, for it unamimously approved of a suggestion that timber standards for the Empire should be adopted, and that inter-communication should be made easier and more definite by a verification of forest terminology throughout the Dominions. The revival of interest in forestry and the pressing nature of the economic and other problems involved necessarily implies the employment of officers who have specialised not only in sylviculture, but in such correlated sciences as geology, climatology and botany. The modern forester, if he is to get the best out of the woodlands entrusted to his care, must possess a professional equipment undreamed of in the spacious days of well-forested England. In modern times it is not sufficient that a forester should know only how to protect his forest : he must be able to cultivate the forest and to make it yield a crop much beyond that which can be reaped from a woodland in which Nature's efforts are unaided. The Conference's resolution, therefore, that a central Empire forestry training school should be established in Britain must be viewed as a step in the right direction. Such a school would not only provide the desired technical education, but it would assist materially in standardising methods and verifying terminology. But the central Empire school in Britain could not provide the special training demanded by Britain's wide-flung Dominions. In Australia, for instance, the conditions are such that a forestry school of the first class would find ample scope for its operations, and such a school is now being established at the joint charges of the Commonwealth and the State.

The Australian delegates at the Conference—Mr. Mackay, of Victoria, and Mr. Lane-Poole, of Western Australia—put the forestry position in the Commonwealth in the clearest light. Unwise exploitation, they said, without adequate conservation and regeneration, threatened Australia with forest bankruptcy unless remedial measures on a sufficient scale were adopted, and Mr. Lane-Poole, speaking for his State, said "exports would cease in twelve years unless the dreadful wastage was stopped by greater cultivation of the remaining forest lands." But to accuse either Mr. Mackay or Mr. Lane-Poole of pessimism would be unjust, for both of these experts in the statement they submitted to the Conference exhibit a fine optimism and a firm belief in Australia's future as a timber producing country. If this optimism, however, is to bear its richest fruit, it is essential that the experts within the Commonwealth should have the heartiest support of the various Governments and a full measure of public sympathy and approval. A country's forests occupy an unique position in its roll of natural resources. Stones of price and rare metals may be founts of wealth to many of its citizens, but once exhausted, no art or skill of man can replace them. But forests unless deliberately sacrificed may remain sources of wealth and avenues of employment for all time, and by the craft of the skilled forester will afford an added increment to that which unassisted Nature will yield. Western Australia has been richly endowed with prime timbers, and in her great forests the pioneer white man found stored up the accumulated wealth of centuries. Much of that wealth has been wasted, but the damage is not irretrievable. It is in the interest of the State, as well as for the good of the Empire, that what remains of the national forest heritage should be an object of earnest public concern.

EMPIRE TIMBER EXHIBITION.

In London, in June and July, 1920, there was held an exhibition of the timbers of the Empire. The people of the United Kingdom have for many years been purchasing foreign timbers—timbers grown outside the Empire—in vast quantities, while in a great many cases the purposes to which these foreign woods were put might have been as well or better filled by some of those grown under the British flag. According to a British official report, the average of timber imports in the United Kingdom for the five years 1909–13 was 10,204,000 loads, of a value of £27,561,421. The economic conditions created by the war at once suggested the enquiry: Can not the whole, or at least a large part, of the enormous sum spent annually on foreign timbers be spent on those grown within the Empire? By those most intimately acquainted with the British trade, and by others who had given attention to the matter, it was realised that much of the British preference for foreign timbers was due to the fact that the public had no knowledge of the source of origin of the woods brought from overseas, and were unacquainted with the forest resources of the Empire. It was decided therefore, that means should be adopted for educating the British people, and the method most likely to produce the desired effect was by an exhibition of Empire timbers, either in their raw state, or worked up into forms which should indicate the special purposes for which the various woods were best suited. The movement found expression in the Empire Timber Exhibition already referred to. All the Dominions whose forests form an item of national economic importance were represented, and Western Australia sent a display that did credit to the State. Included in the exhibits were a panelled room of jarrah—illustrated on another page—a suite of furniture also of jarrah (also shown in the illustration), a variety of samples of West Australian timbers, a great whim wheel, and quite a number of other samples of local woods, either in a manufactured or an unmanufactured state. The Western Australian exhibition attracted much attention and was the subject of not a little enthusiastically favourable comment. The beauty of West Australia's timber and the wide range of their usefulness came as a surprise to many visitors who had no particular interest in timber, as well as to numbers of timber merchants. The Western Australian display was unanimously awarded second place in the whole exhibition, India, with its greater variety of beautiful woods, coming first. The London press spoke in very complimentary terms of our display and was attracted in particular by the capabilities of jarrah, karri, and some others of local woods, as woods eminently suitable for the highest class of furniture and decorative work. The "Daily Telegraph," *inter alia*, said :—

> The wealth of the forest resources of Western Australia was impressed upon a number of gentlemen who yesterday visited the Empire Timber Exhibition at the Holland Park Skating Rink. The company comprised delegates who are attending the conference in London upon Empire Forestry, and also Overseas representatives on their way to the Press Conference to be held shortly in Canada. The many splendid exhibits from Western Australia illustrated the great possibilities of that State in the timber trade of the future. The forests there contain many trees of prime commercial value, but undoubtedly the one which has been the principal factor in securing the State's high reputation as a timber producer is Jarrah.

Other London newspapers spoke in equally high terms of the West Australian exhibit. A West Australian visitor to the exhibition, speaking of the display to a representative of the *West Australian*, said :—

> At this exhibition there were represented timbers from all over the Empire, and the display was of a particularly interesting character, and drew a very large number of people to it during the three weeks that it was open. Western Australia's exhibit attracted a great deal of attenion, and it was generally conceded that, except for India, it was the best exhibit shown. It came as a surprise to the majority of people in London that jarrah could be put to other uses besides sleepers and paving blocks. The jarrah-panelled room and furniture showed them to what uses jarrah is put in Australia, with the result that inquiries were received from a very large number of firms as to the supply of wood for furniture and decorative purposes, as well as for flooring. It is expected that, when shipping becomes more normal, a better business in jarrah will result. In regard to karri, the long beams supplied by the State Sawmills aroused much interest, as did the figures regarding the strengths of this timber when compared with the usual timbers employed in Europe for heavy constructional work. There is no doubt that there is a good market for karri for such purposes as principals, beams, etc. A number of minor timbers, such as sheoak, banksia, and native pear, were much admired. Furniture wood at present is exceedingly difficult to get in England, and the price is almost prohibitive.

In Great Britain in the past the principal timbers of Western Australia have been extensively used for railway sleepers, and in railway wagon and carriage work, and as paving blocks. They are undobutedly eminently adapted for these purposes, but they are equally well suited for use in other directions. In the manufacture of the highest class of furniture, for panelling, and for interior decorations, no better timbers can be had, and the London Exhibition has served to demonstrate this fact beyond a shadow of doubt.

THE EVOLUTION OF THE EUCALYPT.

To trace the course of evolutionary development that has taken place throughout aeons of time, and which has resulted in the eucalypt as we now find it, would be an unprofitable task. Evidence regarding the earlier stages is altogether wanting ; of a later period there are fossilised relics that afford some grounds for building a series of speculations which, in their general conclusions, would probably approach the truth, but it is not until a much later period that data are available from which may be formed some idea of the myriad but slow changes that have in the end produced a tree highly developed in every particular. In a very able paper, contributed to the proceedings of the Linnaean Society of New South Wales by Dr. Cuthbert Hall, of Parramatta, the writer demonstrates very lucidly certain of the processes that have taken place in the differentiation of eucalypt varieties. Much has already been accomplished by way of elucidating the botanical, chemical, and industrial properties and relations of the various eucalypts, the subject of the seedlings and especially of the form of the cotyledons, leaves, and the part these have played in the evolution of the genus has until quite recent days received but little attention. In the task of tracing the life history of the eucalypt, the botanist, and the geologist have yet before them a field, the fringe of which only has been touched. The following note on the subject was presented to the British Association for the advancement of science at its meeting in Melbourne in 1914, by Mr. R. H. Cambage, F.L.S., and it summarises in popular form the knowledge on the matter now available, and is interesting also inasmuch as it suggests the lines along which future enquiries should be made :—

A feature of the genus Eucalyptus is its wonderful adaptability to environment, and a brief sketch will show some of the changes it has undergone.

We have fossil evidence of its existence in Australia since late Eocene or early Miocene, at which time our present mountain system had not developed, and the climate was a mild to warm one. Eastern Australia was then fairly level, and in early Eocene was largely composed of siliceous soils, much of the silica being in a free state, rendering the soils sandy. Subsequent lava flows and deposits of volcanic tuffs yielded a more basic soil, and the final uplift, parallel to the east coast, towards the close of the Tertiary, produced elevations which have a cold climate.

Apparently the early Eucalptus flourished in a sandy soil with a warm climate in Northern Australia. The bark was scaly to rough, the leaves opposite, sessile, horizontal, and generally cordate, and often covered with stellate hairs or coated with caoutchouc. The leaves had a transverse venation, the numerous lateral veins forming an angle of about 65 degrees with the midrib. The flowers were large as compared generally with those of the genus at the present day, and possessed anthers which opened longitudinally in parallel slits. The fruits were generally larger than those of the more recent species to-day, and the chief constituent of the essential oils contained in the leaves was pinene. With some alteration in environment, partly climatic and partly through the advent of more basic soils resulting from volcanic outpourings, a new development took place in the genus, and species were evolved with hard furrowed, fibrous or smooth barks. The mature leaves, which now showed a more oblique or diagonal venation, and were alternate, had gradually developed petioles, which allowed them to hang vertically, so as to present the least possible surface to the sun and thus minimise transpiration, while those which remained sessile protected themselves with a glaucous powdery wax or with a thickened epidermis. Some species of this new type possessed anthers which opened in terminal pores, while cineol became an important constituent of the essential oils. As the genus encountered colder conditions, partly through spreading southwards and partly through ascending the mountains which were uplifted in Eastern Australia towards the close of the Tertiary, a further group was evolved having leaves with almost parallel venation, or the lateral veins now much reduced in number, at an angle of less than about 25 degrees with the midrib, kidney-shaped anthers with the cells divergent at the base and confluent at the summit, and essential oils in the leaves containing much phellandrene and little, or in some cases no pinene. By a comparison of seedling and mature foliage, evidence of transition in leaf form is found in nearly all species and in the cold-country types such as Eucalptus coriacea and E. stellulata the lateral veins of seedling foliage are arranged at angles up to 50 degrees with the midrib, while in mature leaves the angles are less than 10 degrees, and in most cases the veins are practically parallel with the midrib. Eucalyptus leaves with transverse venation are absent from Tasmania, are confined to a very small portion of North-eastern Victoria and practically below the 3,000-foot level in New South Wales, but are common on siliceous soils in Northern Australia, thus showing a preference for the warmer climate. Eucalyptus leaves with parallel venation occur in Tasmania, Victoria, and Eastern New South Wales, while in Northern New South Wales their home is above the 3,000-foot level; and they are absent from Northern and Western Australia, but are found at the highest point that any Eucalptus grows in Australia, viz., 6,500 feet, thus showing a preference for cold and moist conditions."

FOREST WORKING PLANS.

The " Working Plan " is the sheet-anchor and foundation of forestry work throughout the world, but too often the term conveys nothing to the uninitiated, who regard it as a mysterious panacea for all ills of the forest. The objects of a Working Plan are to lay down a definite scheme of management so that a continuity of policy may enable all operations in the forest to be directed towards the fullest possible realisation of the objects for which the forest is maintained.

Before embarking on an undertaking one must have a clear objective, and the objective towards which the forester strives must be set out in the objects of management by the owner of the forest land, whether private individual or Government. In private forests in Europe the yield of timber may be of less importance than the aesthetic appearance of graceful, leafy vistas or the cover for game afforded by woodlands, but in a young country like Australia, where all forest operations are under Government control, the objects of management are a maximum yield in a minimum of time. Reservations must of nescessity be made in the case of every Working Plan to meet local conditions, and special requirements of the market.

Forest country in the neighbourhood of mines may be required to supply pit props and other timbers of given sizes necessary to mining operations. A forest on a watershed may have an essential function in maintaining the purity and continuity of the water supply. It may happen, as in the case of Tuart, a particular species of limited occurrence may be required for local Government use. All such reservations must be set out under the objects of management.

The objective of the forester being fixed, his duty is to provide for a sustained yield. The sleeper hewer and sawmiller of the past have sought to extract the best from the forest with no thought of future supply. It is the duty of the forester to bring the forest into a "normal" state and then limit the cutting to an amount equivalent to the increment put on by the growing trees.

In a virgin forest there is a surplus of over-mature trees which must be utilised, but in a forest under proper supervision trees are removed when they have completed the financial rotation, i.e., grown to an age when the value of their annual volume increment becomes less than the interest on capital invested. The whole object of forest mensuration is to arrive at the rate of growth of different species under varying conditions, so that a maximum yield may be obtained and a crop of trees reaped when economically mature. The forester in a young country is greatly handicapped by the lack of data relating to the rate of growth of trees and their requirements for optimum development.

The collection of data for a Working Plan embraces the whole science of forestry, and in a short article such as this it is impossible to even briefly review methods and operations by which the trained forester takes stock of the present crop on the land and classifies the potentialities of the various types of soil on which he bases his Working Plan Report. The length of this document depends on the intensity of management possible. The original working plans laid down for small cultivated forests in Europe set out in detail the whole of the operations during periods as long as 80 or 100 years, but these soon proved too cumbersome and inflexible to meet changing market conditions. Working plans now lay down the general scheme of management for a whole rotation and the detailed working for a short period such as 5 or 10 years, when the whole working plan is subject to revision.

The Working Plan Report is usually divided into half a dozen chapters on the following lines :—

Chapter I. is a general introduction describing the boundaries of the forest, its previous history and ownership. The factors of the locality influencing tree growth are set out in detail, and notes made on the existing social and industrial features which influence the labour supply and market conditions.

Chapter II. is more technical, and describes the present condition of the forest from a sylvicultural standpoint. The potentialities of trees and soil are enumerated, and existing roads, firebreaks, railway lines, etc., described and marked on maps appended.

Chapter III. sets out the future treatment based on the given objects of management. Directions are given for the application of proposed sylvicultural systems, the provisions to be made for obtaining seed, and the site and management of forest nurseries. The desired subdivision of the area showing the proposed routes of firebreaks, roads and tramways must be fully set out, so that fire protection and transport may be developed as opportunity offers along the right lines.

Chapter IV. deals with the utilisation of forest produce, both major and minor. The method of determining the volume of timber or area to be cut over each year with the object of a substantial yield is definitely laid down. This is the most vital provision of a working plan, for the forester must not trade on capital, but utilise only the interest which has been laid on during the past year in the form of volume increment. Transport and marketing of produce must be provided for and the method of sale to be adopted decided upon.

Chapter V. sets out the necessary provisions for the protection of the forest from damage by fire, animals (human and otherwise), insect and fungus. Under the respective headings the necessary measures for the control of the various menaces to the life of the forest are enumerated.

Chapter VI. is concerned with the administration of the forest, the field and office staff necessary, and their respective duties. Another important clause gives an estimate of expenditure and revenue to be expected, and sets out the very necessary financial provisions for the carrying out of the working plan.

An appendix gives a catalogue of the various maps appended to the working plan and details the provisions to be made for the collection of data for use in future revisions of the working plan.

The Working Plan Report is a document which must not be lightly tampered with, and in the periodic revision any suggested improvements must be submitted to the highest authority before adoption. The Western Australian Forests Act of 1918 wisely provides for the preparation of working plans for each State Forest and Timber Reserve, which shall be subject to the approval of the Governor, and when so approved shall have effect and shall not be altered except on the recommendation of the Conservator.

THE EUCALYPTS ABROAD.

The question has been asked—Will the time ever come when Australia will cease to be the monopolists in the production of Eucalypts? A glance abroad and a careful observation at what is being done in the matter of Eucalyptus cultivation in other parts of the world seem to suggest that the time will come when Australia's monopoly will be nothing more than a mere memory. The reflection is scarcely comforting to the proper pride which Australians should have in their country and its indigenous products. It may, however, afford satisfaction to users abroad of Australian timbers, who foresee in Australia's lack of active forest conscience a time when the areas within the Commonwealth now covered with a fine growth of eucalypts will have dwindled to mere shadows of their former selves, to be assured that, when Australia's supplies have failed, other countries may be able to meet all demands. Only those Australians whose buisness brings them into contact with the question are able to form adequate notions of the extent to which Eucalypt culture is carried on in other lands.

The French were amongst the first to discover the value of the Eucalypt as a timber tree. Writing on the subject nearly 20 years ago, M. Paul Charpentier, an Officer of the French Mint, says :—"The Eucalyptus globulus, of the Myrtaceae family, is of Tasmanian origin, as well as of the Eastern portion of the province of Victoria (Australia), where it is known by the designation of blue gum tree. This species of tree was introduced into Algeria in 1857, since which time plantations have been multiplied, and it is now found upon the whole of the northern littoral of the Mediterranean. Its rapid growth and the extraordinary development of the Eucalyptus globulus, make its cultivation very important. Generally the wood of trees which grow rapidly is light and soft: it changes promptly under the influence of air and damp. It is not so, however, with the wood of the Eucalyptus, which is heavy, hard, and very resistant to the action of air and water. Moreover, it is not liable to attack by insects. The great usefulness of the wood of the Eucalyptus arises from these diverse qualities ; it presents the advantages of the wood of oak, and can even be substituted for "tawn" and teak wood. It is, consequently, largely employed in naval constructions. The majority of the steamers which travel between Australia and Europe are constructed with this wood. The renowned soundness of the whalers of Hobart Town is due to the employment of this wood. Eucalyptus plantations spread aromatic emanations through the atmosphere which are beneficial to the health : these emanations are due to an essential volatile oil, which is very abundant both in the leaves and in the bark. Eucalpytus essence is oxydenated ; it is formed primarily by eucalyptol. This product boils and distils at 170deg. C. : it is slightly soluble in water, though very soluble in alcohol. Fatty and resinous bodies dissolve easily in eucalyptol, which makes it very useful in the manufacture of varnish. The bark of the blue-gum tree contains both tannin and the aromatic principle of the leaves ; employed in the preparation of leathers, it transmits to them a very agreeable characteristic odour, their preservation being thus ameliorated. At the side of Eucalyptus globulus, another very useful species may be noticed, namely, Eucalyptus gigantea. This tree is likewise of very rapid growth ; its wood is very resistant, being three times more so than that of the oak of Riga or Hungary. Its wood, which is hard and very easy to split, is useful in cooperage work, as well as for the making of laths, and a sort of wooden tile for the covering of houses. The usefulness and value of this tree consist especially in the abundance and quality of its fungo-fibrous bark, which serves as a very useful material in the manufacture of paper, bleaching very easily. The Eucalyptus is a native of Australia. A hundred varieties have been naturalised in Algeria. Each of them can be appropriated to a special soil. Thus the Rostrata and the Tereticornis grow in the low and marshy plains, exposed to inundations in winter, but the soil of which is deep ; the Cornuta, Resinifera, Diversicolor, and Globulus are destined for ravines and damp valleys, in good soil ; the Marginata and Melicdora are adapted to high and dry localities and to the mountainous and stony parts ; the Obliqua and Bucoxylon grow better in elevated situations and without shelter, where vegetation is meagre, where winds and drought often occur, etc."

In the United States of America the value of the Eucalypt as a timber tree has been widely recognised and its cultivation is going on systematically. "In general," writes Mr. Gifford Pinchot, formerly Chief Forester of the United States, "Eucalypts may be successfully planted in the sections of the United States suitable for the culture of citrus fruits. They are grown in nearly all the agricultural sections of California, along the coast of Southern Oregon, and to a limited extent in Arizona, New Mexico and Western Texas. Several species have also been planted in Florida and along the Gulf Coast. Eucalypts have been planted most extensively in California, and there the value of different species may best be determined. The rate and habit of growth of the Blue, Sugar, and Grey Gums and a few other species make them superior to other Eucalypts and recommend them especially for commercial plantations. Blue Gum, one of the best commercial species, has been the one best widely planted. Its requirements, characteristics, and methods of propagation are typical to these and other timber Eucalypts."

Since Cyprus came under British rule forestry has occupied a prominent place in the programme of rehabilitation. Acting on the advice of the late Sir David Hutchins, the Eucalypts have received prominent attention and have been largely planted. Reporting on the matter in 1914 the principal Forest Officer of Cyprus gave some very interesting details as to the extent of the work done. As showing how readily the Eucalypt adapts itself and flourishes in Cyprus, he quotes cases of trees which had already attained a height of from 94 to 106 feet with girths of 10 to 11 feet. It should be mentioned that wattle culture also is being largely entered into in Cyprus. Among the Eucalypts planted in Cyprus is Karri (Euc. diversicolor).

In South Africa every Province of the Union is growing Eucalypts. The story of how Natal adopted the wattle and has cultivated it with such success that it now forms the basis of an enormous trade is well known and need not here be repeated. It would seem as if the forest authorities throughout the South African Union were imbued with a whole-hearted enthusiasm for Eucalypts, for every Province is growing them largely and increasing its activities. It is only a question of time when South Africa will be able to supply her own requirements in the way of hardwoods, and the time will come when it will be in a position to cultivate an export trade. The following figures from the annual report of the Forest Department of the Union of South Africa for the year ending March 31, 1918, will give some idea of the extent of Eucalypt cultivation in the Union. In the year named 301,414 cubic feet of Eucalyptus timber was removed from the forest and railway sleeper plantations. From the same report it is gathered that during the year 66,293 cubic feet of Jarrah and Karri were imported. The inference from these figures is unmistakable, and it seems quite evident that the time is not far distant when South Africa will, as has already been said, produce all the hardwoods that she requires.

The Eucalypt, imported from Australia of course, is now largely cultivated all over India wherever the climatic conditions are suitable. The Australian tree takes most kindly to the Indian environments. In a recent annual report of the Board of Scientific Advice for India, it is stated that the main annual increments of Eucalypts are 527 cubic feet per acre per annum in the case of high forest, and of 815 cubic feet in the case of 7-year old coppice, showing that the Eucalypt utilises the productive capacity of the soil to the extent of forming in the case of coppice over 16 tons avoirdupois of wood in one year per acre.

Western Australian Forests.

HISTORICAL.

It is a plain statement of facts to say that Western Australia owes its inclusion in the British Empire almost wholly because it possessed immense forests of valuable hardwoods. The Western portion of Australia 120 years ago was a "Noman's Land." The British Government had not made up its mind whether it should annex it or not, and by way of finding out whether the territory was worth anything at all a small settlement, composed mainly of a military detachment from Sydney, was quartered on King George's Sound. This settlement was given the name of Fredericktown, and Albany now occupies its site. After a while it was decided to withdraw the settlement, but, before doing so, the New South Wales Government informed the Home authorities that there were immense forests of magnificent timber in the Southern portion of the territory, and extending, as far as could be gathered, over many miles northward and westward. This information reached the Admiralty in London and, as timber suitable for shipbuilding was an item of prime importance in the naval dockyards, it was decided that the Western portion of New Holland after all ought to be occupied, and formally annexed to the British Crown. The result of all this was the establishment in 1829 of the Swan River Settlement.

The first buildings in Perth, Fremantle, Guildford, York, Bunbury, Busselton, and throughout the districts occupied by settlers were all of timber found on the land. The necessities of the settlers early made them acquainted with the value of jarrah as a building material, and within 10 years of the foundation of Perth, the question of exporting jarrah—then known universally as "mahogany"—began to attract attention. It is difficult for present-day citizens of Western Australia to realise the obstacles which beset those pioneer exporters. They were without appliances for handling heavy weights. There were no railways: there were no jetties, and at Fremantle every ounce of cargo had to be lightered to and from the vessel lying in Gage Roads. But these early men were stout of heart, and were not discouraged by difficulties and disappointments. By slow stages and with the help of bullocks and horses they managed to get the sawn timber to the beach. It must be recollected also that there was no such thing as a steam sawmill in those days. Everything was done by hand. A very common method of converting a tree was, after it had been felled, to dig a sawpit close by the trunk as it lay, and then laboriously by hand cut it into the sizes wanted. In a local paper printed in 1845 there is a curious account given of the difficulties attending the transport of a log that weighed seven tons from the Canning to Fremantle. We read that

" after great labour the log was slung in chains and then transported for a quarter of a mile, when the chains broke like bundles of twine." Then the writer of the paragraph goes on to say, " it will be a matter of great difficulty to get this huge log to the beach, and we confess that we do not see how it is to be got on board any vessel."

The first steam sawmill in the Colony was erected in Guildford, and the day it was opened was held as high holiday, and the Governor and many of the principal residents in Perth journeyed to Guildford by water to see the marvellous process of cutting jarrah into boards by a circular saw driven by steam. The next sawmill was close to Mt. Eliza, Perth, and was in Mr. Monger's timberyard. Mr. Monger seems to have been the first to open a regular yard for the sale of sawn local timbers.

It should be mentioned here that for half a century after the foundation of the Colony, all the boats and barges plying on the River Swan and the Murray River and at Albany were built of jarrah. Ocean-going vessels were also constructed at the places named, some of these making voyages to India, the Cape, and to England. The suitability of jarrah as a shipbuilding material, was early recognised by the British authorities, and it was put upon the Admiralty list and upon Lloyd's list as a timber suitable for shipbuilding.

Necessity, they say, is the mother of invention. Those who pioneered the West Australian forests were hard put to by reason of the distance from the centres of civilisation. Shipping was erratic, and there were often long intervals between the arrival of ships from England. The settlers, therefore, were thrown upon their own resources, and they put the materials that they found at hand to purposes which to us in these later days would seem curious in the extreme. For instance, when iron rails for bush tramways could not be had, rails made of such timbers as wandoo and tuart were used, and over these, trucks with logs and timber travelled. In the earlier flour mills of the Colony the whole of the machinery was of local timber, different varieties being used in different parts of the outfit. The wheels were usually made of jarrah, the cogs were very often of tuart. All bearings were of native woods also, and answered the purpose marvellously well. The first " safe " of the Colony was built of jarrah, and placed in the Treasury at Perth, and for many years this wooden box contained the Government's hard cash. On farms the jarrah plough 60 or 70 years ago was as common as the steel one of to-day, and in many other matters in which metal is now used on farms, local timber was made to serve similar purposes. The first jetty in Western Australia was built at Arthur's Head, Fremantle. It was, of course, wholly of jarrah cut within a mile of its site. It was a private concern, and belonged to one of the whaling companies then established at the port.

EXTENT OF THE FORESTS.

From the very foundation of the Colony curious misconceptions have existed as to the extent of the forests of Western Australia. The fact that good timber was found growing in and around Perth and extending southwards indefinitely seems to have given rise to the notion that the whole country to the south of Perth and over 100 miles back from the Indian Ocean was one vast prime forest, and in the earlier estimates this whole area was generally set down as capable of producing marketable timber. One early authority puts it in this way :—

> The forest area is included within the parallels of south latitude 31 degrees to 35 degrees, and is estimated to cover an area of at least 30,000 square miles. It may be stated that a belt of forest land exists between the latitudes abovementioned, in some places extending inland for 100 miles, but the best jarrah wood is found in the hill ranges, and not nearer than 15 or 20 miles from the coast, and of this the areas occupied by the principal eucalypti are:—
>
> | | Square miles. |
> |---|---|
> | White gum (*eucalyptus redunca*) .. .. .. | 10,000 |
> | Jarrah (*eucalyptus marginata*) .. .. .. | 14,000 |
> | Karri (*eucalyptus diversicolor*) .. .. .. | 2,300 |
> | Tuart (*eucalyptus gomphocephala*) .. .. | 500 |
> | Red gum (*eucalyptus calophylla*) .. .. .. | 800 |
> | York gum (*eucalyptus loxophleba*) .. ... | 2,400 |
>
> The white gum grows generally in all forests, excepting in that part of the colony where karri abounds. It is, however, found in the greatest profusion eastward of the Darling Range. The wood is used for many purposes in the colony, but it does not appear as an article of export.

A more recent authority stated :—

> The area under prime forests in Western Australia is not yet accurately known. At the present moment the work of classification is being pushed on, and until this is completed the acreage carrying trees of commercial importance and value will not be available. Mr. Ednie Brown in 1896 made a rough estimate:—
>
> | | Acres. |
> |---|---|
> | Jarrah, chiefly (with Blackbutt and Redgum) .. | 8,000,000 |
> | Karri .. .. | 1,200,000 |
> | Tuart .. .. | 200,000 |
> | Wandoo .. .. | 7,000,000 |
> | York Gum, Yate, Sandalwood, and Jam .. .. | 4,000,000 |
> | Total area of the principal forest surface of Western Australia | 20,400,000 |

These figures probably are an approximation of the areas in which the timber named may be found, but they certainly do not represent the facts so far as forests of commercial timbers are concerned. Wandoo, for instance, is placed at 7,000,000 acres, but this tree is seldom to be found in masses deserving to be called forests. It is scattered over immense areas as "Savannah Forest." The same may be said of the figures regarding jarrah and some of the other woods named. At the present time it may be estimated that the existing area of prime forests in Western Australia does not exceed 3,000,000 acres, AND THE BULK OF THIS AREA HAS BEEN CUT OVER.

EXPLOITATION.

So long as the forests were only called upon to supply the local demand for timber no special regulations were put in force by the Government, but, when an export trade developed, the authorities considered that for revenue purposes it was necessary that those who cut down timber should pay for the privilege of doing so. All over the South-West there are scattered deserted sites of sawmills, which at one time furnished material for export. The earliest mills were in the Canning district, amongst them being Jarrahdale, using Rockingham as a port, and connected with it by a private railway. The Canning district was worked by the Canning Jarrah Company and others, and gradually, as the export trade increased, other plants were put down at suitable places, such as Quindalup and Geographe Bay.

In the karri country the earliest mills were at Karridale and at Torbay, and later at Denmark. A generation ago the regulations governing the conversion of timber were vastly different from what they are to-day. At that time licenses to cut and remove timber on Crown lands were issued by the Commissioner for Lands, the Collector, or any Sub-collector of Revenue, or any Resident Magistrate, on the following terms :—

1. To fell and hew timber to be used locally or exported as piles or balks, for each man—£3 per month ; or, in case of a pair being employed--£5 per month (such licenses included all men employed in removing timber).

2. To fell, cut, and remove timber, or split and remove fencing, firewood, or shingles, for each man—5s. per month.

3. To cut sandalwood outside proclaimed areas, or to gather zamia wool, gums, or other such substances, for each man—2s. 6d. per month.

No license was granted for a period less than one month or more than 12 months.

Special licenses were also granted for one year at the following rates :—

For any quantity not exceeding 640 acres of land—£20.

For any quantity exceeding 640 acres, but not exceeding 1,280 acres of land—£40 ;

but such licenses did not permit the cutting, hewing, and removing of logs and piles.

In addition to the above, there were also granted to certain large companies concessions and special leases on terms approved by Her Majesty's Secretary of State for the Colonies. The maximum term for which such licenses were granted is 42 years.

On the 13th February, 1891, in the Legislative Council, the Colonial Secretary laid upon the table the following return showing the timber concessions and special timber leases in existence at the end of 1889. This table reads as follows :—

Name.	Number.	Acres.	District.	Annual Rent.		
				£	s.	d.
1. Western Australian Timber Company, Lockeville ...	...	About 200,000	Sussex	Free.		
2. Rockingham Jarrah Timber Co.	...	250,000	Cockburn Sound	50	0	0
3. Keane, E. V. H.	12/1	100,000	Canning	200	0	0
4. Davies, M. C.	12/2	46,000	Sussex	150	0	0
5. Gill & Co.	12/3	2,880	Swan	133	6	8
6. Honey, R.	12/4	1,920	do.	100	0	0
7. Yelverton, H. J.	12/5	51,840	Sussex	75	0	0
Total	...	652,640		£708	6	8

This table is a vivid illustration of the recklessness with which valuable timber rights were granted. Most of the concessions and special timber leases mentioned above have expired, or ownership has been altered.

No. 1 State Mill, Manjimup. Note big Marri (redgum) trees in foreground.

The following return shows the concessions and leases in existence up to the 30th June, 1920. No concessions or leases are now granted, exploitation being carried on solely under sawmill permits, hewing permits, and firewood permits.

CONCESSIONS.

Concessionaire.	No.	Locality.	Term.	Original Area.	Present Area.
Millar's T. & T. Co., Ltd. ...	12/0	Cockburn Sound	1-1-1899 to 31-12-1901 1-1-1902 to 31-12-1915 1-1-1916 to 31-12-1929	250,000	250,000
Millar's T. & T. Co., Ltd. ...	12/1	Canning ...	1-1-1893 to 31-12-1924	100,000	82,750
Millar's T. & T. Co., Ltd. ...	12/2	Sussex ...	15-1-1883 to 14-1-1925	46,000	45,389
			Total	396,000	378,139

LEASES.

Leases.	No.	Locality.	Term.	Original Area.	Present Area.
Ainslie, James	145/113	Nelson ...	1-1-1899 to 31-12-1923	4,480	4,389
Ainslie, James	149/113	Nelson ...	1-1-1899 to 31-12-1923	4,480	4,092
Ainslie, James	150/113	Nelson ...	1-1-1890 to 31-12-1923	4,480	3,522
Millar's T. & T. Co., Ltd. ...	186/113	Wellington ...	1-1-1899 to 31-12-1923	27,000	16,012
Millar's T. & T. Co., Ltd. ...	227/113	Wellington ...	1-1-1901 to 31-12-1925	4,480	2,743
Millar's T. & T. Co., Ltd. ...	228/113	Wellington ...	1-1-1901 to 31-12-1925	4,480	4,130
Millar's T. & T. Co., Ltd. ...	229/113	Wellington ...	1-1-1901 to 30-12-1925	4,480	3,962
Millar's T. & T. Co., Ltd. ...	230/113	Wellington ...	1-1-1901 to 31-12-1925	4,480	4,480
Good, Frederick Daniel ...	244/113	Murray ...	1-7-1899 to 30-6-1924	17,280	13,259
Good, Frederick Daniel ...	257/113	Nelson ...	1-10-1899 to 30-9-1924	33,280	28,876
Millar's T. & T. Co., Ltd. ...	261/113	Murray ...	1-10-1899 to 30-9-1924	58,270	22,937
The Timber Corporation, Ltd.	268/113	Nelson ...	1-10-1899 to 30-9-1924	49,920	33,938
Wittenoom, Edward Horne ...	269/113	Wellington ...	1-10-1899 to 30-9-1924	5,000	2,080
Macmurtrie, Wm.	288/113	Wellington ...	1-7-1900 to 30-6-1925	36,960	12,637
Ainslie, James	291/113	Wellington ...	1-1-1901 to 31-12-1925	17,920	17,308
Millar's T. & T. Co., Ltd. ...	296/113	Wellington ...	1-1-1900 to 31-12-1924	11,520	4,146
Millar's T. & T. Co., Ltd. ...	297/113	Wellington ...	1-1-1900 to 31-12-1924	13,440	12,771
Ainslie, James	299/113	Murray ...	1-7-1900 to 30-6-1925	19,840	18,795
McNeil, Alexander James ...	309/113	Wellington ...	1-4-1901 to 31-3-1926	21,310	793
Wittenoom, Edward Horne ...	322/113	Murray and Wellington	1-4-1902 to 31-3-1927	44,800	20,000
Wittenoom, Edward Horne ...	225/113	Wellington ...	1-4-1902 to 31-3-1927	1,280	1,205
Smith, Henry Teesdale ...	330/113	Murray ...	1-7-1902 to 30-6-1927	10,240	7,781
Smith, Henry Teesdale ...	331/113	Murray ...	1-1-1903 to 31-12-1927	9,600	7,194
			Total	409,020	247,047

In 1917 the royalty, which was formerly 1s. a load, was increased to 2s., and since then a system of sale by tender of the right to remove forest products was initiated, and by the system a royalty more in proportion to the value of the product is obtained. Under the term "permits" are included hewing permits, milling permits, and firewood permits.

The Forests Department.

ITS INCEPTION AND DEVELOPMENT.

It is only reasonable to suppose that a just appreciation of the value to the community of the Colony's immense forest wealth would have been early entertained by those called upon to administer public affairs. The reckless granting of valuable concessions and special leases on terms and conditions which had no real relationship to the worth of the article given away, showed how little the timber asset was regarded and how little its economic meaning was realised. One, therefore, can experience no surprise when it is learned that the administration of the forests for more than sixty years was left to the tender care of officials attached to departments whose purpose was best served and whose importance was increased by an early alienation of as much of the timber country as was possible. If anyone wanted forest country for agriculture or for grazing, the desire was met with prompt generosity. It seldom seems to have occurred to the official mind that timber might be the best crop the land was capable of producing, nor did anyone trouble to inquire whether the applicant could be better suited elsewhere. The result of this lack of provident discrimination on the public behalf was that all over the timbered areas we now find scores of abandoned homesteads, the partially cleared portions rapidly returning to their original forested state.

Until 1896 the Department of Lands and Surveys administered the national forests. In the year named, the Government, with tardy recognition of past mistakes, decided that there should be a Department of Forests, and the new department was constituted not as a separate and independent factor in the administrative services, but as an appendage of the Department of Lands and Surveys. The arrangement thus decided upon can scarcely be termed a happy one. The interests of a Lands Department and a Forest Department, when viewed in the full light of public advantage, have nothing necessarily antagonistic in them. But in a State where the public good is a factor which varies according to the political exigencies of the moment, the officer whose business it is to alienate the land and the politician whose object it is to keep in favour with his constituents, are apt to hold views opposed to those of the officer whose duty it is to conserve forest wealth. Time after time land has been "reserved" in Western Australia for specific forestry purposes, and time after time it has been alienated despite the protests of the forest officials. And some of these alienations have been as purposeless in their results as they were wanton in their conception for the lands have since been abandoned.

Mr. J. Ednie Brown, who had visited Western Australia at the instance of a private firm which proposed to begin cutting operations in the jarrah and karri forests, was appointed first Conservator of Forests. Western Australia is under a heavy debt to Mr. Ednie Brown. His knowledge of forestry was as wide as it was practical and accurate, and to an unusually large experience in sylviculture he added an intimate acquaintance with Australian forest botany. His "Report on the Forests of Western Australia" is still a standard book of reference on the subject.

At his instance the title of Forestry Department was altered to that of Woods and Forests Department. The following paragraph from his first annual report is characteristic of the man. "It is my privilege," he writes, "to state the fact that within the space of one year the Colony, from an indefinite and comparatively little known market (commercially) has bounded into a leader of export timber trade with most parts of the world. Perhaps it is not too much to say that this position has been achieved simply by making known what we possess in quantity, quality, and variety of matured indigenous forests."

But the new department was not without its troubles. The Treasurer of the day was ready enough to snatch the department's surplus income, but having no adequate idea as to the real value of forests to the community, he cut down the items in the department's estimates which were to be devoted to the upkeep and preservation of the forests. Let Mr. Ednie Brown tell his troubles in his own words.

> It was early recognised by the late Minister for Lands that such an important branch of the rural economics of the State as that of its forests should be controlled by a direct department of its own, and it is mainly due to his credit, and that of the present Under Secretary for Lands, that this was done.
>
> The importance of this step was also at once acknowledged by Parliament, and the necessary funds for establishing such a State Department were at once, without dissent, passed upon the Estimates.
>
> It is true that a larger provision for this important and revenue-producing branch of the service might have been made by the Government, and would, I am convinced, have been readily granted by the House; but perhaps a small beginning, upon the lines indicated, was advisable under the circumstances.
>
> Accordingly the Estimates provided, under the heading of "Forestry," for an expenditure of only £2,210. This included the salaries of Conservator, Clerk, three Forest Rangers, Nurseryman, one or two more labourers, office rent, and various incidental expenses, such as seeds, travelling allowances of Conservator and Rangers, etc.

Jarrah Regrowth.

As may be easily understood, the amount set down for the Department was found to be thoroughly inadequate for its requirements, and hence several of the items had to be overdrawn for absolute necessities; but no expenditure of any great extent was incurred pending Parliamentary sanction.

At present the position of the Department in some respects is somewhat of an anomaly, as all applications for special timber licenses and the issue and controlling of licenses of all kinds are made to and pass through the Lands Department.

This, in many respects, I find somewhat awkward and is certainly not conducive to that thorough control and grasp of the working of the Department which is so essential in an important office of this kind.

Although matters have gone on smoothly so far, and good work has been done under existing circumstances, still it must be remembered that we are only as yet in the initiatory stages of the great timber trade of the Colony, and that a year or two will show very great developments in this branch of the Colony's resources, therefore it is imperative that we should be prepared for this coming expansion of business.

I have therefore submitted to the Minister, in order that the Department should be in touch with all matters connected with the forests of the Colony, that all applications for special timber licenses, etc., etc., should be received, issued, granted, and generally dealt with by the Woods and Forests branch of the service—all, of course, subject to his direction, through the Under Secretary for Lands. The adoption of this proposal would, I am sure, be appreciated by the public generally, who at present are somewhat confused and possibly irritated by the dual positions.

In the Estimates for the current year, therefore, I have, amongst other things, calculated upon this suggestion being carried out, and have provided for an officer whose duty it will be specially to see after this part of the work of the Department.

It is incumbent, as the work of the Department extends, that its expenditure should also increase, and it will therefore not be surprising that the amount asked for this year is considerably in excess of the sum provided for in 1895-6. This, of course, includes the expense of the formation of large plantations of exotic trees and the development of the Department generally, which will be referred to in another portion of my report.

The revenue account for the year reported upon justifies Mr. Ednie Brown's gratification at an expanding timber trade. For the preceding year the receipts had been £2,389, while in that he reviewed the revenue amounted to £9,135.

The disastrous effect of political interference upon Western Australian Forestry is well known, and here it may be as well to adduce an instance which strikingly illustrates the evils of a system or want of system which solemnly sets aside an area of land for a specific purpose and one that is in the public interest, and permits it, after money and labour have been spent upon it and it is in a fair way to accomplish its original object, to be appropriated by any private individual who has sufficient political pull. Mr. Ednie Brown, early in his tenure of office, made the acquaintance of the Sandalwood Experimental Farm at Pingelly. This is how he refers to it in his First Annual Report :—

> About two years and a half ago the Bureau of Agriculture, Perth, deciding to try an experiment of planting Sandalwood, purchased some 20 acres of land near Pingelly, from the late Western Australian Land Company, for this purpose.
>
> A portion of this area—some five acres in all—was ploughed, fenced, and planted with nuts during the season of 1895.
>
> This planting was, however, unavoidably carried out too late in the year—about August—and hence the results at the end of the season were not at all satisfactory.
>
> The kinds of nuts sown were a quantity of our native Sandalwood (Santalum cygnorum), and the Indian or true variety (Santalum Album).
>
> The native nuts came up freely; but those of the Indian species did not show any signs of germination, so that although treated properly in every respect, I fear that they were either bad or had been heated in some way during transit from India.
>
> During the season following, that is, in the winter of 1896, some further planting of native nuts was carried out by the Bureau; but again, although also treated properly, and with satisfactory preliminary results, the very dry summer of that year proved disastrous to the young plants.
>
> In the month of October, 1896, the Bureau handed over the whole plantation to the Government, who placed it under the entire jurisdiction of this Department.
>
> Recognising that the previous experiments connected with this plantation had not been at all successful, owing chiefly to the fact that the sowing of the seed had been done too late in the season, I decided that a still further experiment should be made this year upon the lines chiefly of early planting. With this view I obtained the permission of the Minister for Lands for an early start in this direction, and for embracing the remainder of the area within the scope of our operations.
>
> With this view, the whole of the remainder of the 20 acres comprising the plantation was enclosed, the old ploughed portion re-ploughed as it contained only a few plants, and the whole re-planted and put under the following:—
>
> Sandalwood Nuts.
>
> Sugar Gums planted in bamboos and pots.
>
> Pines of sorts.
>
> The cost of fencing, planting, etc., came to £70 13s. 10d.
>
> As we go to press, the results in connection with this experiment are most satisfactory, and as the plants and nuts have had a good start during the rainy season I am sure that I shall be able to give a good account of them in next year's report.

Mr. Ednie Brown's regrettable death in 1901 was something of a disaster to the Western Australian forests. A period of 15 years lapsed before the work was taken up at the point at which he laid it down.

In 1901, it was reported by the Acting Conservator of Forests that the Pingelly Sandalwood Plantation and also another reserve of a similar kind at Meckering were doing well. "Some 13,530 Sandalwood nuts were sown upon both blocks during the year, a large percentage of which have germinated, some of the plants making in many instances phenomenal growth, and proving Sandalwood to be anything but the slow grower it was supposed to be." So matters went on, and the goodly experiment promised well. But before long a local person of influence appeared on the scene and he coveted the sandalwood plantation, even as Ahaz coveted the vineyard of Naboth. There was much correspondence and many reports were asked for and made. The Forest Department fought gallantly to save its sandalwood farm from sacrifice on the altar of political expediency, and it was ably assisted by district officials of other departments. These friends of a worthy adventure proved that the reserve was doing well and that the Sandalwood was thriving, but the despoilers advanced superior arguments and Ahaz had his way ; and the plantation which had cost so much and promised so well became a grazing lease at £3 a year. But Ahaz has not been without his troubles. In 1907 the Mourambine Roads Board applied to have the old Sandalwood Reserve cut up into Suburban lots and thrown open for selection. But the grazier countered effectively, it would seem, for he still claims to have pasturage rights over the area.

An officer of the Forests Department visited the old Pingelly Sandalwood Reserve in the middle of 1920 and reports, *inter alia*, as follows :—

"On the portion of reserve that had not been cultivated or cleared, but on which Sandalwood nuts were planted in amongst existing trees, there are now about 150 Sandalwood trees growing, three of which were over 15 inches in circumference, whilst about 30 others ranged from 6 to 12 inches in circumference. Table below gives approximate measurements of three best trees—

No.	Estimated Height. feet.	Circumference at Base. inches.	Remarks.
A.	10	19¼	2ft. 6in. from base, circumference is 18¾in.
B.	12	18½	4ft. from base, circumference is 15¾in.
C.	15	16½	5ft. from base, circumference is 13½in.

Tree No. C. shows dead wood up one side.

The trees from 9in. in circumference upwards were seeding very freely, and beneath these trees last year's nuts were now sprouting.

From these trees it seems certain that a fair crop of marketable sandalwood could be obtained from a plantation under favourable conditions after about 20 years.

From what could be seen on the reserve, I feel certain that Jam is a desirable host for Sandalwood and is probably the tree that accompanied it throughout the fair rainfall area. The Sandalwood Plantations would therefore be able to produce Jam wood as a side line."

Between the date of Mr. Ednie Brown's death and the appointment of the present Conservator of Forests, Mr. C. E. Lane-Poole, the Forests Department, through lack of trained skill at the head of it, became little more than an agency for collecting royalties and other fees due from timber converters. But, with the arrival of the present Conservator, the Department took a new lease of life and entered upon a developmental period such as it had not previously experienced. It was essential, if the work of the Department were to be properly carried out, that legal sanction should be given to the necessary plans and methods of forest protection and extension, and in the Parliamentary session of 1918 a bill for that purpose was introduced and became an Act towards the close of the year named. Under that Act the Forests Department was constituted and the Conservator has been granted considerable power, and a proportion out of the net revenue of the Department has been earmarked for forestry purposes, and this will enable some real forestry work to be carried on. The first thing to be done was to make a stocktaking of the State's forest assets. Mr. Ednie Brown had estimated these at over 20,000,000 acres, of which jarrah was credited with 8,000,000 acres, and karri with 1,200,000 acres. The classification that is just about completed by the Department will probably reveal the fact that there exists to-day not more than 2,000,000 acres of prime jarrah country, and approximately a quarter of a million acres of karri. These figures are eloquent. They tell, with a clearness that admits of no misunderstanding, how small when compared with the total area of the State or even the agricultural area is our forest heritage. The work of conserving and improving the forest is now in hand, and will be pursued steadily year by year under working plans which are being carefully thought out and systematised. Under the new Act the methods of exploitation in the forests are defined, and it is no longer possible for anyone to obtain special leases and concessions as was done a generation ago. When the old leases and concessions expire, all-exploitation will be carried on under permit.

The activities of the Department include schemes of planting not only of indigenous timbers but of pines. In the Mundaring Catchment Area pine planting operations are being vigorously pushed on, and the preliminary steps are being undertaken for extensive pine planting on a large area between the Midland railway and the sea, a little to the North of Perth. Foresters have to possess and exercise long vision, and in the years to come, there can be no doubt this area North of Perth will be covered by big pine trees and will become one of the lungs of the Metropolitan Area. The work of the Department includes also the regeneration of sandalwood in the areas near the coast where once it was plentiful, and also the protection and regeneration of mallet, a tree whose value lies in its bark. As a tanning agent mallet bark has no equal in Australia and few in the world. The Department recognises that, if its work is to be done effectively, those in charge of the various operations in all the States must possess skill in forestry, and with that object the Department has established a school at which apprentices will be trained in scientific and practical forestry and so be fitted to worthily play their parts in the great scheme of forest protection and extension.

The activities of the Department are not, however, confined to questions dependent upon timber exploitation and its economic management. The forests of the State are rich in many valuable things besides the raw timber. There are barks for tanning, oils, gums, and resins. The extent of the resources of the forests in these directions is not yet known, but, largely due to the energy thrown into the question by the Forests Department, the Federal and State Governments have established in Perth a Forest Products Laboratory, in which such matters as have been referred to will be investigated and the values ascertained. Further particulars as to the work of the Forest Products Laboratory are given on another page. Much of the wastage in the Western Australian forests is due to fire, and a good deal of the time of the Department is occupied in dealing with this aspect of the subject. No opportunity is lost of impressing upon residents in and near forests the necessity for being careful in the use of fire, and it is hoped that persistent propaganda of this kind will result in a wakening of the public conscience to the fact that a fire sweeping through a jarrah forest will destroy valuable property which belongs to the people themselves.

Production.

EXPORTS AND DOMESTIC CONSUMPTION.

It is only when one comes to examine the figures relating to the timber and other products already taken out of the State's forests that some notion of the supreme part which the woodlands have played in the country's development may be obtained. The growth of the export trade was slow. Shipping was scarce and intermittent, and for many years the means of getting timber to the places of shipment were primitive and ineffective, as well as those for loading the timber into vessels. The first shipment officially noted was in 1836, when a couple of hundred loads, valued at £2,500, were sent to Great Britain. From 1846 onward the export trade became more regular, but it was not till 1865 that the export exceeded 2,000 loads a year. Up till 1877 the growth was comparatively small : in 1878 over 11,000 loads were sent away, and from that date the increase was regular and continuous. In 1897 47,866 loads were exported, and two years later the volume suddenly expanded to 138,274 loads. The 200,000 mark was reached in 1909, and in 1913 the largest quantity ever sent abroad in one year, 272,397 loads, was reached. The value of the shipments in that year was over £1,000,000. Up to the middle of 1920 a total of 3,992,997 loads, valued at £16,199,342 had been exported from the State. But large additions must be made to these huge figures if the wealth that the forests have brought to the State is to be ascertained. Sandalwood has to be taken into account. For three quarters of a century sandalwood has been regularly exported, principally to the East. Up to the middle of 1920 the total sent away amounted to 331,205 tons, valued at £3,061,661.

Then there are tanbarks. The whole of the eucalypt family contain in their bark, leaves, or wood a certain proportion of tannin, the active agent in the process of tanning. In most of the species, however, the proportion is so small that under present conditions the barks of most of them cannot be used economically for commercial purposes. One noteworthy exception is the mallet (*Eucalyptus occidentalis var. astringens*). The percentage of tannin in this tree runs as high as 45 per cent. The bark has been largely exported, particularly to Germany in pre-war days. The first shipment sent away was in 1903, when mallet bark to the value of £859 was shipped. Next year the value of the export rose to over £32,000, and in the following year the phenomenal figure of £154,087 was reached. That was high water mark. Since then exports have gradually diminished until in the year ending June, 1920, the value of the bark sent away was only £22,121.

It is to be regretted that no sufficient steps were taken at the time that the value of mallet bark as a tanning agent was discovered to protect the tree. The result was that it was recklessly and wantonly exploited. The total value of the mallet bark sent away between 1903 and 1920 was £973,812.

What the forests have yielded and the part they have played in the development of Western Australia becomes strikingly apparent when the figures relating to forest exploitation are gathered together and summarised. The totals are as follows :—

	£
The total value of timber, sandalwood, and mallet bark exports amounts to	21,212,892
Total value of timber products used locally	9,200,000
Mining timber, estimated at	27,900,000
Total	£58,312.892

The forests of the State have, therefore, already yielded products to the enormous amount of some £58,000,000, and to this must still be added the value of gums, resins, and fibres, industrial and domestic firewood, regarding which no official statistics are available.

Finance and Output of the Forests.

The figures which tell of the operations of the Forests Department are of the greatest value. A study of them reveals several outstanding features. The first of these is that viewed as a commercial proposition the Department has shown a handsome profit every year since its foundation. The following table discloses the fact that between 1895 and 1920 the Department contributed £560,772 to Consolidated Revenue. Under "The Forests Act, 1918," three-fifths of the net revenue is earmarked for forestry purposes. Under this wise provision the Department will be enabled to undertake the big and urgent task of repairing the forest wastage of the past.

REVENUE AND EXPENDITURE.

The following statement shows the Revenue and Expenditure of the Department since its inception in 1895:—

Year.	Revenue.			Expenditure.		
	£	s.	d.	£	s.	d.
1st Jan. to 31st Dec., 1895	3,175	5	2	1,108	5	5
1st Jan. to 31st Dec., 1896	4,838	11	2	2,020	11	5
1st Jan. to 31st Dec., 1897	12,320	6	4	3,489	14	4
1st Jan. to 31st Dec., 1898	30,150	6	3	3,356	5	7
1st Jan. to 31st Dec., 1899	16,999	11	3	2,438	7	5
1st Jan. to 31st Dec., 1900	15,525	19	2	2,648	11	10
1st Jan. to 31st Dec., 1901	18,477	16	2	2,747	6	3
1st Jan. to 31st Dec., 1902	18,752	11	7	4,301	6	1
1st Jan. to 31st Dec., 1903	20,478	9	1	3,789	3	4
1st Jan. to 31st Dec., 1904	20,018	19	4	4,192	16	9
1st Jan. to 31st Dec., 1905	18,479	18	6	5,089	18	6
6 months, 1st Jan. to 30th June, 1906	10,973	18	4	3,385	1	9
1st July, 1906, to 30th June, 1907	22,783	1	5	6,207	15	2
1st July, 1907, to 30th June, 1908	23,498	13	3	8,801	14	3
1st July, 1908, to 30th June, 1909	29,484	3	8	9,030	12	6
1st July, 1909, to 30th June, 1910	31,549	6	11	8,531	0	9
1st July, 1910, to 30th June, 1911	37,477	3	5	8,862	16	8
1st July, 1911, to 30th June, 1912	44,560	10	10	10,469	4	10
1st July, 1912, to 30th June, 1913	48,236	14	0	11,463	2	11
1st July, 1913, to 30th June, 1914	53,038	16	0	12,092	15	3
6 months, 30th June to 31st Dec., 1914	22,906	0	0	5,468	14	0
1st Jan. to 31st Dec., 1915	45,725	13	9	8,869	15	11
1st Jan. to 31st Dec., 1916	29,820	12	10	9,575	3	2
1st Jan. to 31st Dec., 1917	36,128	17	11	10,263	2	5
6 months, 1st Jan. to 30th June, 1918	22,113	1	8	6,199	1	11
1st July, 1918, to 30th June, 1919	42,050	12	4	10,872	18	3
1st July, 1919, to 30th June, 1920	59,220	4	3	12,737	15	8
	£783,785	4	7	£178,013	2	4

It will be seen from the above statement that to the 30th June, 1920, the revenue exceeded the expenditure by the large sum of £560,772 2s. 3d.

What the forests have yielded in the way of timber, etc., for export is shown in the table which follows. It must be borne in mind that these figures take no cognisance of timber used locally, nor of domestic firewood nor of mining timber.

SUMMARY OF EXPORTS OF FOREST PRODUCE SINCE 1836.

Year.	Timber.		Sandalwood.		Mallet Bark.
	Loads.	Value.	Tons.	Value.	Value.
		£		£	£
1836*a*	200	2,500	...	...	...
1837	...	...	...	...	...
1838	...	...	...	...	...
1839	...	...	...	...	...
1840	...	...	...	...	...
1841	...	...	...	...	...
1842	...	...	...	...	...
1843	...	...	...	...	...
1844	*b*	163	...	...	...
1845	...	...	4	40	...
1846	51	255	32	320	...
1847	244	1,120	370	4,444	...
1848	67	333	1,335	13,353	...
1849	...	...	...	...	...
1850	210	1,048	...	...	...
1851	25	268	219	1,593	...
1852	141	806	...	...	...
1853	1,044	5,220	...	...	...
1854	1,170	7,023	...	...	...
1855	1,538	12,076	...	...	...
1856	1,410	9,671	...	...	...
1857	1,384	9,449	280	2,524	...
1858	585	2,340	745	7,455	...
1859	1,345	6,051	1,278	17,259	...
1860	1,096	4,932	1,687	16,360	...
1861	555	2,497	2,558	24,945	...
1862	1,376	7,151	2,393	21,541	...
1863	658	2,963	2,807	25,265	...
1864	1,166	5,508	2,724	24,520	...
1865	3,679	15,693	1,686	13,490	...
1866	1,713	6,849	2,965	23,722	...
1867	1,135	4,541	2,305	18,442	...
1868	160	638	3,256	26,045	...
1869	3,598	14,273	4,124	32,998	...
1870	3,144	17,551	6,112	48,890	...
1871	4,370	15,034	3,366	26,926	...
1872	740	2,590	3,942	31,536	...
1873	1,363	4,771	6,290	62,916	...
1874	6,912	24,192	7,057	70,572	...
1875	6,847	23,965	6,646	66,465	...
1876	4,381	23,743	6,577	65,772	...
1877	6,723	36,979	4,247	31,851	...
1878	11,618	63,902	4,675	35,064	...
1879	12,545	69,742	4,667	35,001	...
1880	13,251	66,252	5,097	51,970	...

a The exports up to the year 1834 consisted only of supplies to shipping, of which no record is kept. *b* Not available.

SUMMARY OF EXPORTS OF FOREST PRODUCE, ETC.—*continued.*

Year.	Timber.		Sandalwood.		Mallet Bark.
	Loads.	Value.	Tons.	Value.	Value.
		£		£	£
1881	15,855	79,277	7,716	77,165	...
1882	18,730	93,650	9,605	96,050	...
1883	19,940	79,760	7,031	56,250	...
1884	17,234	68,936	2,620	20,960	...
1885	16,963	67,850	4,527	36,216	...
1886	12,523	50,092	3,431	27,450	...
1887	7,096	28,384	4,317	34,533	...
1888	10,515	42,060	4,470	33,525	...
1889	15,770	63,080	6,385	57,465	...
1890	23,444	82,052	5,136	51,355	...
1891	25,479	89,179	3,760	37,600	...
1892	21,653	78,419	5,716	42,870	...
1893	10,259	33,888	3,893	32,160	...
1894	21,274	74,804	2,784	23,430	...
1895	25,105	88,146	3,851	30,863	...
1896	30,912	116,420	6,848	65,800	...
1897	47,866	192,451	5,852	49,480	...
1898	81,723	326,195	4,349	31,812	...
1899	138,271	553,198	4,084	29,719	...
1900	114,508	458,461	5,095	39,038	...
1901	143,012	572,354	8,864	73,931	...
1902	125,135	500,533	7,995	61,771	...
1903	154,969	619,705	4,406	37,913	859
1904	161,446	654,949	4,510	25,417	32,876
1905	174,190	689,943	5,521	38,817	154,087
1906	*c* 176,614	708,993	8,848	70,958	140,720
1907	*c* 128,091	511,923	9,212	65,999	98,773
1908	*c* 197,390	813,591	9,564	77,668	79,934
1909	*c* 216,609	867,419	4,805	37,456	59,633
1910	*c* 241,482	972,698	8,228	70,775	93,733
1911	*c* 248,990	986,341	6,907	65,506	83,470
1912	*c* 225,942	903,396	3,154	27,533	49,094
1913	*c* 272,397	1,089,481	6,260	47,589	47,377
1914*d*	*c* 125,595	502,153	4,702	39,800	18,197
1915*e*	*c* 190,370	808,392	8,375	78,926	6,127
1916*e*	108,642	441,991	6,271	61,381	10,208
1917*e*	77,813	310,893	7,230	72,669	18,959
1918*e*	68,725	274,141	6,494	81,834	16,886
1919*e*	82,715	344,119	8,998	117,072	18,875
1920*e*	101,306	487,666	13,945	233,586	22,121
Total	3,992,997	16,199,342	335,205	3,061,621	951,929

c Approximate figures only. *d* Six months ended 30th June. *e* Year ended 30th June.

The amount of timber taken yearly from the forests and its value enable some idea to be formed as to the highly important part the woodlands play in the State's economy. The figures given in the following tables cannot be maintained, and if the forests are to continue to furnish employment for workers, it can readily be understood that a policy of regeneration must accompany exploitation. Systematic cultivation of cut-over regions and the planting of new areas alone can assure continuity and permanence to the forests as producers of wealth and avenues of employment. The first table gives the total timber production (sawn and hewn) for the year ending 30th June, 1920.

TOTAL TIMBER PRODUCTION.

	In the Log.		In the Square.	
	Loads.	Cub. ft.	Loads.	Cub. ft.
Total Milling Timber	399,080	19,954,000	174,420	8,721,000
Total Sawn Timber from Private Property	6,131	306,550	2,759	137,950
Total Hewing Timber	127,576	6,378,800	31,894	1,594,700
Total Miscellaneous Timbers ...	2,149	107,450	967	48,350
Total	534,936	26,746,800	210,040	10,502,000

Round Piles and Poles ... 144,554 running feet.
Heart-in Beams ... ... 6,222 ,, ,,

There is further taken from the forests timber for mining purposes and for firewood. The volume under these heads is represented below :—

MINING TIMBER AND FIREWOOD CONSUMED DURING THE YEAR ENDED 30TH JUNE, 1920.

Locality.	Wood Fuel Consumed.	Mining Timber Consumed.	Sleepers.	Total.
	tons.	tons.	No.	tons.
Greenbushes Mining Fields	9,000	...	...	9,000
Collie Coal Fields	...	4,664	...	4,664
Metropolitan Area	138,834	...	...	138,834
Golden Mile, Coolgardie, Norseman, Kunanalling, Golden Ridge and Kanowna	314,643	7,398	...	322,041
Northern Goldfields, Ora Banda, Comet Vale, Menzies, Kookynie, Laverton, Mt. Morgans Districts	74,941	2,186	...	77,127
Southern Cross, Marvel Loch, Mt. Rankin, Burbridge, Westonia, Golden Valley, and Bullfinch Districts	32,985	17,138	...	50,123
Goldfields Water Supply Pumping Stations, Nos. 5, 6, 7, and 8, plus other small pumping plants	9,762	...	...	9,762
Eastern Goldfields Districts (Household)	38,107	...	...	38,107
Eastern Goldfields (Bakers) ...	15,180	...	...	15,180
Batteries (State and Private) and Factories outside Golden Mile	8,764	...	...	8,764
Eastern Goldfields Tramways ...	13,866	...	...	13,866
Eastern Goldfields Electric Power and Light	51,064	...	...	51,064
Eastern Goldfields Producer Plants and Blacksmiths (as charcoal)	1,000	...	...	1,000
Sleepers for tram lines (6ft. 6in. to 7ft. x 7in. x 4in. to 7ft. x 4½in.)	...	...	2,986	...
	*708,146	31,386	†2,986	739,532

* Exclusive of Mining Timber and Firewood consumed on the Murchison and other Distant Goldfields not mentioned above. † Not included in total.

Cutting operations in the forests are carried on under various forms of authorisation. These and the areas respectively covered appear in the following table :—

	Total Areas.	
	Original.	Present.
	acres.	acres.
Concessions	396,000	378,139
Leases	409,020	247,047
Sawmill Permits	802,507	793,356
Hewing Permits	25,281	18,784
Sawmilling Permits	120,796	106,653
Firewood Permits	75,690	67,450
Miscellaneous Permits	524,411	504,726
Grand Total	2,353,705	2,116,155

The concessions and leases are of old standing, and all of them will expire before 1928. At the end of the terms for which they were granted, the areas included in them will be exploited under the permit system as laid down in the Forests Act.

The Training of Foresters.

Not the least of the many disabilities under which forestry in Australia labours is the lack of trained men, that is, of men who, in addition to the knowledge gained by practical work in the forests possess that amount of book learning or scientific knowledge which is essential if they are to get the best out of the calling they have chosen, and are to render effective service to the State that employs them. In every one of the States of Australia there is a vast quantity of work to be accomplished in repairing the damage done by generations of exploitation and in protecting and extending the forested areas so that they shall remain permanent assets. But without men who have had some special training for the work, it is useless to entertain hopes for the accomplishment of the task. So necessary is this training that in every State arrangements have either been made or are in progress for imparting the necessary knowledge to those who may enter a forest school as apprentices, with a view of reaching higher grades. Forestry as a life calling for youth offers many attractions. Almost the whole of the work is in the open air and under conditions eminently suited to physical and mental health. To a man who has entered the service under a prescribed training, the prospects of advancement are exceptionally favourable.

In order that the forest service of Western Australia may be recruited with men who have been specially trained, the Forests Department has upon its staff a qualified forestry instructor, whose duty it is to impart information to all apprentices at an Apprentices' School in the forest country, as well as continuing his instructional work amongst them during the portions of the year when they are engaged in work in the field.

The field service of the Forests Department is composed of two classes of officers, namely, the Professional Division and the General Division. The first named class consists of officers who have had at least two years' science training at a University and have subsequently studied at and obtained the diploma of a recognised forestry school. The General Division is composed of those whose qualifications are in accordance with the requirements laid down under the Act. The clauses dealing with these requirements are as follows :—

15. No person shall be appointed or promoted to an office in the general division unless he has passed such examination as may be prescribed as a qualification for such office.

> But it shall not be necessary for such examination to be passed by any person in the permanent employment of the department prior to the commencement of this Act, unless such person is an applicant for promotion.
>
> 16. (1) The Conservator may provide for the training of forest officers, and may employ such youths as he may think fit as apprentices.
>
> (2) At the expiration of the period of apprenticeship (which shall not exceed four years), any person who is certified by the Conservator as having fulfilled the conditions of his apprenticeship may be appointed to a position in the general division of the department prescribed as one for which such person is qualified.

The course of instruction for apprentices at the school will extend over a period of four years and the following outline furnishes some idea of the scope and nature of the training :—

First Year.—The successful applicants will proceed to the Forest School for Apprentices.

During the first six months the apprentices will receive instruction and carry out forest operations under the control of the Instructor in Forestry.

A general knowledge of the fundamental sciences on which the practice of forestry is based will be imparted during this period.

Subjects for the first year :—

1. Elementary mathematics.
2. Geology and Physiography.
3. Botany (elementary).
4. Entomology.

During the following six months the apprentices will be employed in whatever forest operations are being carried out.

While engaged in practical work in the field printed lectures will be forwarded to the apprentices fortnightly in the subjects set out for each year.

Second Year.—In the second year the apprentices will return to the school for two months' training.

On returning to practical work in the bush, the boys will be placed, as far as possible, in localities where they will receive training in nursery and plantation work.

The subjects to be studied during the second year are :—

1. Soils.
2. Botany—systematic and economic.
3. Surveying.
4. Forestry—History and Value.

Third Year.—In March of the third year the apprentices will return to the school for a further two months' instruction.

On returning to the bush the apprentices will, where possible, be employed in classification and working plan survey work.

Subjects for third year—

1. Sylviculture (including nursery work)
2. Mensuration.
3. Valuation.
4. Protection.

Fourth Year.—In the final year of their apprenticeship, May and June will be spent at the Forest School.

During this fourth year the apprentice will be attached to a district, in order to learn, under the District Forest Officer, the whole of the routine work, including clerical work, general work and timber inspection. He will be required to submit independent reports on matters receiving consideration in the district. Opportunities will be given for visiting various mills and wood-working industries and provision made for continuous employment in at least one sawmill.

Subjects for fourth year :—

1. Forest Management and Working Plans.
2. Utilisation.
3. Transport and forest engineering.
4. Forest Policy.

Examinations.—The following examinations will be compulsory :—

1. Examination at end of first six months' instruction at the school.
2. Examination during two months at the school during three following years.
3. Final examination in December of fourth year of apprenticeship.

In the event of an apprentice failing at any examination, the Conservator shall decide whether his indenture be cancelled or whether he be allowed to sit for a subsequent examination, but no increment shall be added to such apprentice's pay until he shall have passed a subsequent examination, and the period between the two examinations shall be added to his term of indenture.

Rate of Pay.—Subject to an apprentice passing the necessary examination, the following rates of pay will apply :—

First year	12s. 6d.	plus	18s.	subsistence	allowance	per week.
Second year	17s. 6d.	,,	18s.	,,	,,	,,
Third year	22s. 6d.	,,	18s.	,,	,,	,,
Fourth year	30s. 0d.	,,	18s.	,,	,,	,,

Employment in the Forest Service.—An apprentice, on passing his final examination to the satisfaction of the Conservator, will be granted a certificate which, as vacancies occur, will entitle the holder to a position as forest guard in the general division of the Forest Service.

The forest guard must remain a temporary employee until reaching the age of 21 years, when, as vacancies occur, he may be promoted to a position on the permanent staff as Assistant Forester. This and all future promotions will be subject to the passing of such tests and examinations as the Conservator may think fit. Refresher courses, under the Instructor in Forestry, will be provided for forest guards and assistant foresters from time to time as part of their ordinary duties.

What has been said has reference to officers of the second division only. The first, or professional, division of the forest service is made up of men who after study have obtained a diploma at a recognised forestry school. There has hitherto existed in Australia no forestry school for professional officers whose equipment, both in regard to teaching staff and opportunities for field study is sufficiently comprehensive to permit of its being classed with some of the great schools in Europe. To remedy this and also to provide a supply of Australian trained professional officers for Australian forests, a fully equipped forest school is in course of formation. The project was approved at two conferences of Premiers and the Federal Government has also signified its approval and its willingness to assist. When it is duly established this Australian forest school will be in a position to supply the completest course of instruction to forest officers, and its diploma will be a guarantee of professional knowledge and ability and will secure for it respect not only within Australia but abroad.

Early Timber Industry.

In 1833, it is on record that 30 tons of "mahogany" in logs was lying at Cockburn Sound, and its owner was advertising it as available for exportation. In the same year "mahogany" was exported to the Cape, and is said to have realised good prices, but no details are to be had as to the quantity or the sums it brought. In July, also of that year, a collection of samples of Western Australian woods, particularly those adapted for shipbuilding, was sent to London. The value of the local timber for shingles does not seem, in the earlier years, to have been too clearly realised. Thatch, we know, was pressed into service, and it is on record that in 1834 30,000 shingles were imported from Sydney. But even in these early years the desirability of cultivating the export market for "mahogany" was clearly understood, and several proposals were made to that end, including the formation of more than one company. The samples sent to London appear to have come under the notice of the Admiralty authorities, for in April, 1836, it is reported that 200 tons of timber, "the growth of the Colony," have been ordered by the British Admiralty. It seems also that at the date mentioned there was in England a "Home Corresponding Committee," whose functions were to foster in every way possible the interests of the young Colony of Western Australia. Writing on the subject in April, 1837, the editor of the *Perth Gazette* says, "the white gum tree is pronounced by our millwrights to furnish a superior wood for machinery of every description, and if once introduced into England would obtain considerable consumption." With a fine optimism, he goes on to say that "English piano makers should be told about our mahogany, and he is sure that they would take payment for pianos, half in cash and half in mahogany," and he then suggests that mahogany should be included in the next shipment and sent to London with our oil and wool. Incidentally it may be stated that the word "jarrah" seems first to have been suggested in place of the term "mahogany" for our principal timber in the beginning of 1843. A Mr. C. D. Ridley, of Perth, made the suggestion, and at the same time he proposed to form a company with a capital of £2,000 to carry on the export of "jarrah." In this gentleman's opinion the name "mahogany" is not suitable ; "it is not mahogany, and it should be introduced into England under its proper name, as a wood eminently serviceable for many purposes." The details of the 200 tons shipped to the order of the British Admiralty by the " Hero " are of some interest, and one may assume that part at least of the order was to be used in the construction of ships of war. The pieces were :—

Thick stuff, 10ft. 10in.—80 loads, 12 to 15 broad.
Thick stuff, 8in.—40 loads.
Thick stuff, 6in.—40 loads.
Planks, 4in.—20 loads, 10 to 12 broad.
Planks, 3in.—20 loads, 10 to 12 broad.

That the Admiralty was pleased with the timber is very evident from the fact that in May of next year a Perth citizen secured a contract for a cargo of 400 tons of local timber for use in Royal Naval Dock Yards. Adelaide appreciated the timbers of the West, and many shipments were made, one of the earliest of these on record being that of 30 tons by the " Empress " schooner in 1847. The determination of the colonists to make the most of the magnificent heritage of timber finds another illustration in a proposition made in January, 1848, when the prospectus of the company for the export of Western Australian timbers was published. The capital of this concern was to be £50,000 of 2,000 shares of £25 each. The company was floated especially to push the export of jarrah, which, the prospectus stated, resisted the *teredo navalis.* It was not the intention of this company to cut timber on its own account. Its purpose was to buy the timber from cutters and export it, and when it received foreign contracts it proposed to fill them by sub-letting the orders to hewers and cutters. But even in these early days the pessimist was in evidence in Western Australia, for in the local paper at the time a correspondent recommended that this company should ship only beams as " logs would, through defective hearts, give foreigners a bad impression." Next year, 1849, an enterprising citizen sent a small shipment of jarrah to India, and letters received intimated that the Government of India was much pleased with it, and it is stated further that there is a big market in India for Western Australian timber if it can be delivered there at about £7 a ton. In the early 50's the timber industry was quite busy, and a good deal of cutting took place in new districts. Particulars are in existence of 110 tons of timber which was lying at the beach at Leschenault ready for shipment when an opportunity should occur. Mr. G. Shenton also at that period contracted for 100 tons to be cut at Augusta ; about the same time 80 loads of timber had been felled back from Bunbury, and 60 of these had been carted to the beach awaiting shipment. The fact that our timbers were appreciated for shipbuilding purposes finds further corroboration in the many exports of wooden trenails to England. In February, 1852, for instance, the " John Panter " sailed for London, and amongst her cargo were 101 loads of timber (kind unspecified, but most likely mahogany) and 14,700 trenails. The wood of which the trenails were made is not specifically mentioned, but from reports of these at other periods, it seems that wandoo (white gum) was the tree which supplied them. In local shipbuilding right along the wandoo trenail was almost universally used. In 1854 vigorous efforts were made to increase the trade in timber with the Eastern Colonies, and early in the year the "Hamlet" sailed from Fremantle for Adelaide and Melbourne with a full cargo of timber, and the "Struan," which had arrived from London with general goods, loaded up with timber in Bunbury and took it across the Bight. These shipments seem to have been purely speculative, and not in response to definite orders, and one reads with some pain that the mahogany per the "Struan" to Melbourne failed to find a market. Towards the end of the same year, strangely enough, very good prices were obtained for a shipment of our timber which was taken there from Mangles Bay. In fact this sale was so heartening to the industry here that it is on record that "the timber trade became busy and buoyant." By the early 60's the timber trade with India had become somewhat regular, and had assumed considerable dimensions. In February, 1861, two ships laden with timber left for India, one having Madras as a port of destination and the other Nagapatam.

Between 1870 and 1903 the sawmilling industry became thoroughly established, and the exports rose from 3,144 loads, valued at £17,551, to 154,969 loads, valued at £619,705. At the latter end of this period the rate of cutting so alarmed statesmen of the time that the Royal Commission already referred to was appointed to investigate the forestry question. Unfortunately its findings were disregarded and, instead of subsequent governments restricting the cutting of timber, they encouraged it. In 1906 the export was 176,614 loads, valued at £708,993, and in 1913–14, the year prior to the war, the export had grown to 272,397 loads, valued at £1,089,481.

It is unfortunate that the bulk of the export trade in jarrah has been in the form of sleepers, and this has given quite an erroneous impression in foreign countries as to the value and capabilities of our principal timber. The sleeper hewer is particularly wasteful of good timber in his methods. In the mills a recovery from logs of 45 per cent. is quite common, but it is seldom that the sleeper-cutter recovers more than 25 per cent. of the round log. Under the regulations of "The Forests Act, 1918," sleeper hewing is much restricted, and licenses are granted only to those who were engaged in the business before that date. One object of the Forests Department is to make jarrah known as a timber of the highest class and fit for the worthiest and best purposes, and when it is seen only in the form of sleepers, it is difficult to get outsiders to understand or appreciate its many admirable qualities.

Timber Trees of Western Australia.

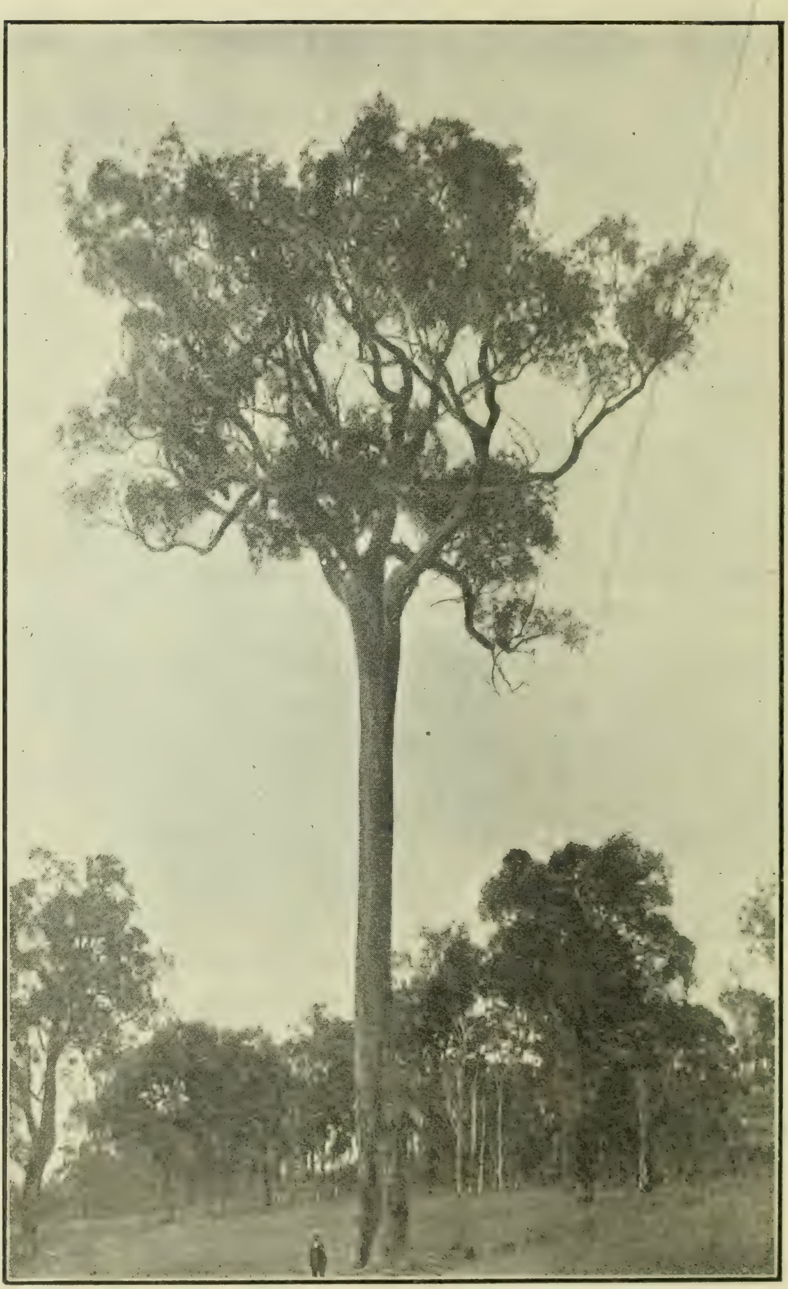
The forests of the State are rich not only in the variety of the timbers they hold, but in the quality of these. It is curious as well as interesting to observe that the principal timbers of Western Australia are peculiar to the State, and are not to be found growing anywhere else. Jarrah, and some other of our eucalypts, it is true, have found a warm welcome in countries overseas, particularly in South Africa and California, and in some parts of Southern Europe, and Morocco and Algeria. But in every case these trees have been raised from seed or seedlings brought from their native home, the State of Western Australia.

Geologically speaking, Western Australia is the oldest part of our island continent. Time was when what is now known as Western Australia was the only part of Australia showing above the water, and at that time it was clothed with a rich and variegated tree life. Science has made it possible to determine the comparative ages of species of trees, and investigators have arrived at the conclusion that such trees as tuart, yate, karri, and jarrah are very much older than any of the members of the eucalypt family to be found in what are known as the Eastern States. It seems probable that, when Central and Eastern Australia in course of time appeared above the surface, vegetation spread from the West to the East, undergoing in the course of myriad ages many modifications, so that none of the West Australian species are to be found in the Eastern States. It is likely that the conditions existing in those far-off ages were favourable to the spread and propagation of certain eucalypts, but that others, such as tuart, not finding the conditions they demanded in a new environment, did not spread, and can only be found in the habitat they have occupied for unknown ages—the limestone belt extending along the coast from 31 deg. 40 min. to 33 deg. 40 min. South.

A short description of the principal trees of the State will be of interest, as conveying not only some idea of the variety of the indigenous timbers, but of their value economically and industrially :—

JARRAH (*Euc. marginata*).

This tree is the principal timber of the State. In the early day it was called mahogany, owing to the resemblance it had to the Honduras timber. About 1860 the name was altered to jarrah, as it was generally recognised that this was a better timber than mahogany, and that it had so many fine qualities that it deserved a name of its own. Jarrah is the name given to the tree by the aborigines.



Jarrah.

The tree grows to a height of about 100 to 120 feet, with a bole of 50 to 60 feet, and a diameter of 72 inches.

Weight per cubic foot (green)—68lbs.
At 12 per cent. moisture—55lbs.
Transverse strength—15,000lbs. per square inch.
Tensile strength—15,500lbs. per square inch.

A hard wood, but easily worked, and therefore used for almost every purpose. It is strong enough to be used for beams, and its colour and texture are such that it is daily becoming more and more prominent as a cabinet wood. One of its remarkable qualities is its durability when exposed to the worst conditions. The timbering in the first houses built when the Colony was established is still sound to-day, and the post-and-rail fences erected by the earliest settlers are still standing. Its extraordinary durability has, however, rather cheapened it in the eyes of the outside world, where it has commanded a readier sale as sleeper or paving block wood than for purposes where more expensive wood is generally used. It is to be regretted that the exploitation of the jarrah forests has been conducted practically solely for the sleeper market. Since 1836, the export of timber from the State amounted to 3,992,997 loads, valued at £16,199,342, the bulk of which consisted of jarrah.

It is on Lloyd's list of shipbuilding woods, and jarrah ships in the early days plied between Western Australia, India, and other parts of the world. Its durability has made it renowned for bridge, wharf, and harbour work, while the telegraph service of the State is dependent upon supplies of jarrah poles.

It is to be found scattered throughout the South-West over some 13,000,000 acres of country within the 25 to 45 inch rainfall belt. The main belt of timber, however, stretches from Chidlow's Well in the North, along the Darling Range to the extreme South of the State, in the neighbourhood of Albany. The total area of prime jarrah forests is probably not more than 2,500,000 acres, and is all on this laterite capped range of hills.

It regenerates itself well, but the constant firing of forests has resulted in the destruction of the young growth in many parts of the forests. The recovery in milling operations is from 45 to 50 per cent. of the round log.

Karri.

KARRI (*Euc. diversicolor*).

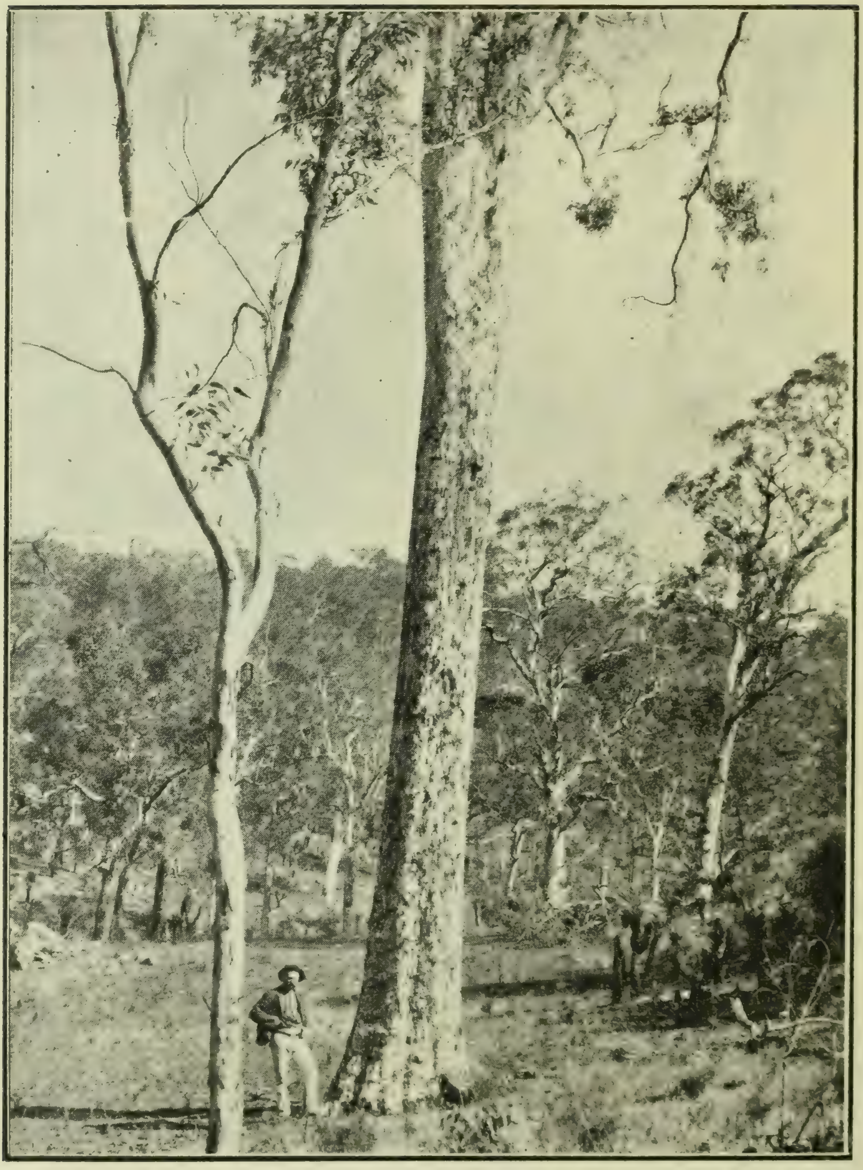
The second most important tree of the State ; it grows to a great height (trees of 280 feet having been measured), with a bole of 100 to 140 feet, and diameter of eight to 10 feet.

Weight per cubic foot (green)—72lbs.
At 12 per cent. moisture—58lbs.
Transverse strength—17,300lbs. per square inch.
Tensile strength—18,750lbs. per square inch.

A hard strong wood. It closely resembles jarrah timber, but the grain is longer, and it is a much stronger wood. It is beyond doubt a splendid superstructural timber, and is strongly to be recommended for heavy beams, roof purposes, etc. *It is not durable in the ground, and does not resist white ants.*

It is on Lloyd's list of shipbuilding timbers, and is suitable for all purposes where large sections and strength are necessary. It has been found very satisfactory for wooden pipes, and it makes a good wagon spoke, but its main use up to now has been for railway wagon scantling and telegraph arms. The English Railway Companies and the London Post Office authorities are strong in their praise of the timber for these purposes. It has suffered very much through its being so easily confounded with jarrah. As in all young countries, timber in Western Australia has in the past been valued according to its durability as a fence-post or a sleeper, and karri, though immeasurably superior in other respects, has been condemned owing to its failure when put to such uses. It is confined to the wettest portion of the South-West of the State, and its Northern limit is Nannup and the upper waters of the Donnelly, whence it spreads Southwards and South-Eastwards to Denmark. There is then a gap in the belt, and it is to be met with again near the Porongorup Range ; another isolated patch occurs on the extreme South-West near the Leeuwin ; this was the place whence the first karri was exported from the State, and is more commonly known under the name of Karridale. In all it is doubtful whether more than 500,000 acres of prime karri forest can be reserved. It regenerates itself well, and it forms the only forest of the State that carries a dense undergrowth of shade-bearing species.

The sawmiller recovers from 38 to 40 per cent. of the round log.



Wandoo.

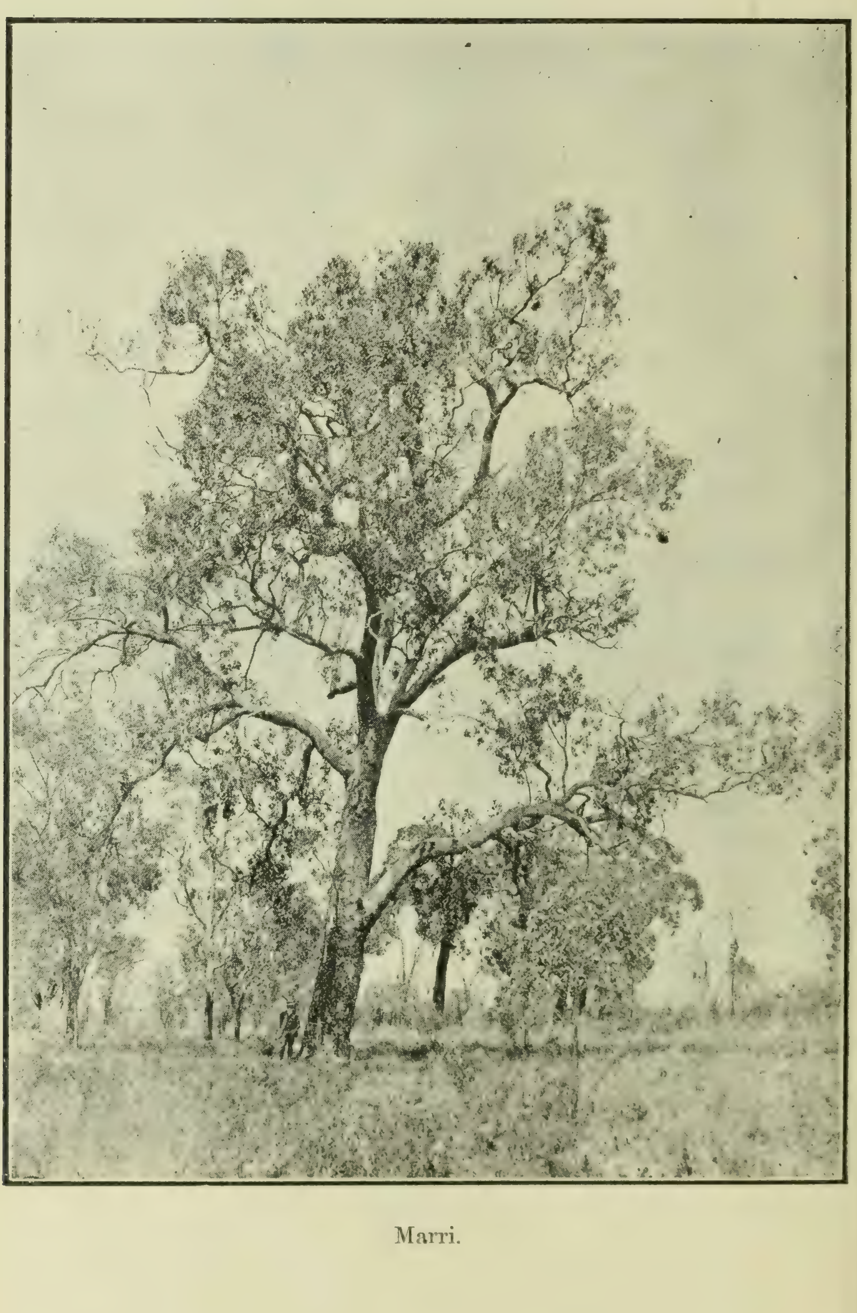
WANDOO (*Euc. redunca var elata*).

A tree attaining a height up to 100 feet, with a bole of 30 to 40 feet, and diameter of four feet.

Weight per cubic foot (green)—79lbs.
At 12 per cent. moisture—71lbs.
Transverse strength—16,100lbs. per square inch.
Tensile strength—16,100lbs. per square inch.

This wood is hard, strong, and durable. It is used for bridge construction, wharf planking, wheelwright, millwright, knees of boats, and shipbuilding generally. It makes an excellent trenail. It is very satisfactory for all turnery work, such as jute and cotton bobbins, telegraph insulator pins, etc. Its main use, however, is for wagon scantling for the railway stock of the Government Railways of the State. It gives a life of 25 years in under-carriages of trucks. The top plank of these trucks is always made of wandoo, which stands the wear of the unloading and loading better than steel; also, the stanchions of the trucks are of wandoo. A remarkable quality which this timber possesses is that when used in conjunction with steel there is no chemical action between the wood and the metal. Bolts have been taken from underframes of trucks after 20 years' use and been found to be quite as clean as when put there, while the auger marks were still visible in the holes. The value of this timber is so well recognised by the Government of this State, that permits for cutting it can only be obtained if the timber is to be used by State Departments ; in other words, the timber may not be exported. (*See* Tuart.)

It is to be found growing in the South-West portion of the State on the edges of the jarrah belt. It does not grow in close forests, but in open savannah forests, and is to be found mixed with jarrah and red gum. The soil is usually a clay sub-soil, though occasionally it is to be met with on the sand-plain country.



Marri.

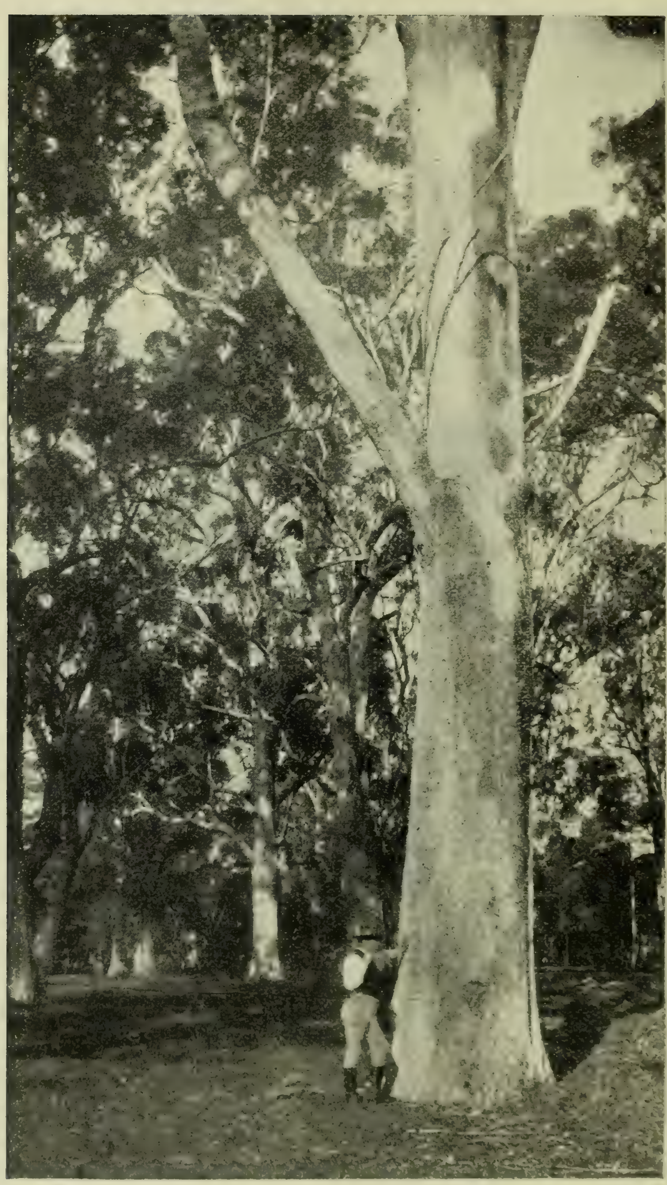
MARRI (RED GUM) (*Euc. calophylla*).

A tree attaining a height of 90 to 100 feet, with a bole of 40 to 50 feet, and diameter of six to seven feet.

Weight per cubic foot (green)—72lbs.
At 12 per cent. moisture—56lbs.
Transverse strength—16,600lbs. per square inch.
Tensile strength—20,200lbs. per square inch.

This tree yields a light-coloured strong wood. It is easily worked, and were it not for the presence of gum veins would be among the most valuable timber in Western Australia. Unfortunately, the gum or kino occurs in such quantities that it is difficult to find a tree free enough from gum to make it profitable to saw it up. It is used for all purposes where strength and elasticity are required. Timber hewers always take out the hickory shafts from their carts and replace them by marri shafts. Heavy poles used in the large whims which carry the great jarrah and karri logs to the mills are of marri. In the whim itself the fetchels, which are trusses to connect the pole with the axle bed, are also of marri. It makes a good axe and tool handle, and there would seem to be a future for it for all small turnery work. It must not be confounded with the red gum of Victoria and New South Wales, which grows along the Murray, and which is far better growing timber, but is not nearly so strong as the Western Australian marri. The gum or kino yielded by this species contains a heavy percentage of tannin. Hide powder analysis shows that it contains up to 68 per cent. From earliest settlement it has been used by settlers to convert hides into leather, but unfortunately it has not been possible to use it to the extent that it should, owing to the fact that it imparts to the leather a red colour. It is hoped that investigations by leather chemists will discover the means of decolourising this valuable product, the source of which is inexhaustible.

It occurs throughout the jarrah belt, but, like blackbutt, is to be found generally on the better alluvial soils in the valleys between the laterite capped ridges. Marri soil is generally considered, from an agricultural point of view, a degree better than jarrah soil, which, from an agricultural standpoint, is of little use.



Tuart.

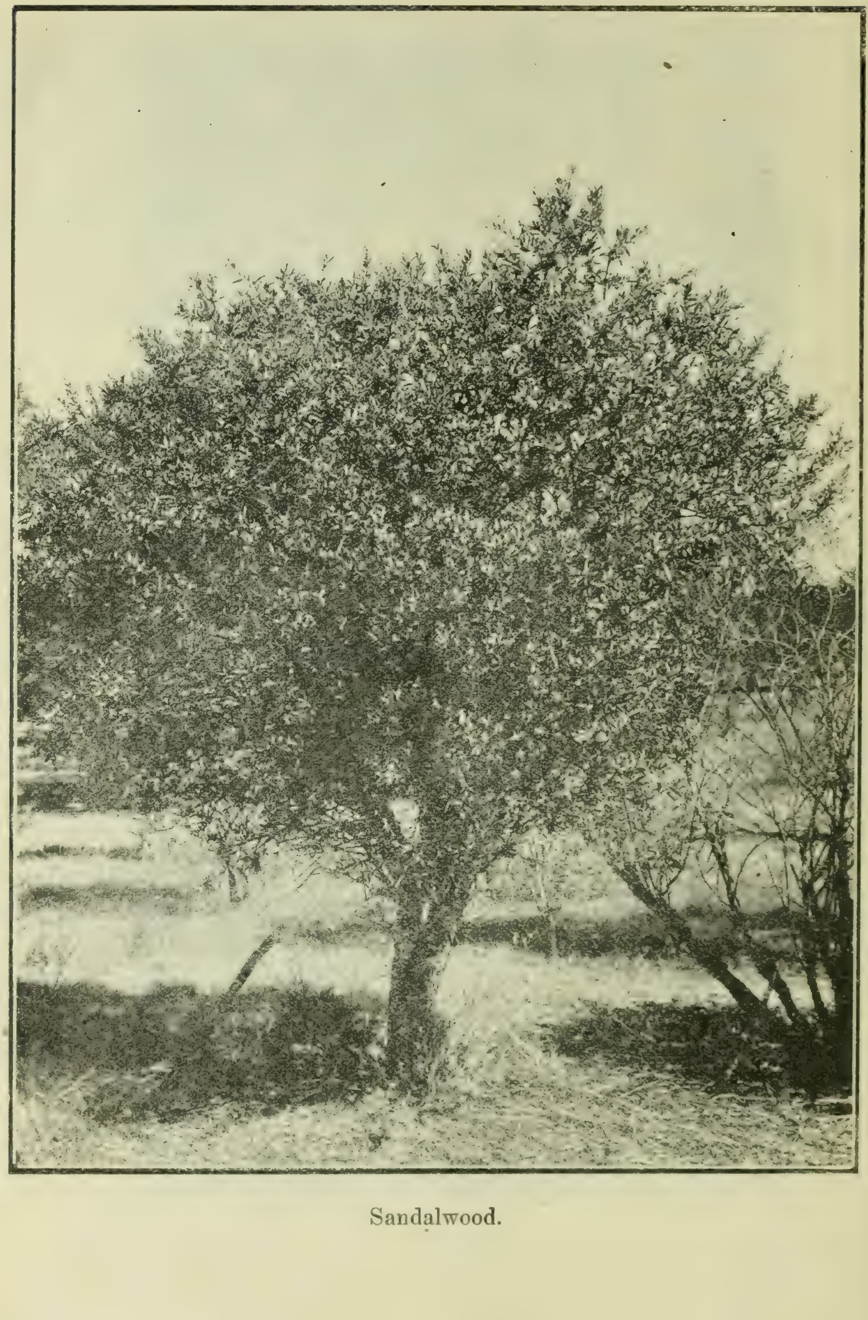
TUART (*Euc. gomphocephala*).

A tree attaining a height up to 100 feet, with a bole 35 to 45 feet, and a diameter seven to eight feet.

Weight per cubic foot (green)—78lbs.
At 12 per cent. moisture—68lbs.
Transverse strength—17,900lbs. per square inch.
Tensile strength—16,500lbs. per square inch.

The timber is hard and dense with an interlocked grain, its colour is yellow. It vies with wandoo in strength and toughness. The timber is used for wheelwright work, especially the large naves required for the 9ft. wheels of the timber whims. Its main use, along with wandoo, is for railway wagon and truck construction. The late Chief Mechanical Engineer in Western Australia, Mr. E. S. Hume, reduced the maintenance of his trucks from £3 7s. 6d. to 10s. per year per truck by substituting for steel tuart and wandoo in the under-carriages. Like wandoo, the cutting of tuart except for departmental purposes is forbidden, and its export prohibited.

It is confined to the limestone formation, and on this formation it stretches in scattered lines from Lake Pinjar Southward along the coast as far as Sabina River, some 12 miles North of Busselton. Curiously enough it is not to be found anywhere else in the State, although limestone occurs all round the coast line. The best tuart is to be found between Sabina River and Capel, and it is doubtful whether it will be possible to reserve more than 5,000 acres of first class tuart country. Between Sabina River and Capel River the distance is about 12 miles.



Sandalwood.

* SANDALWOOD (*Santalum cygnorum*).

A small tree attaining a height of 12 to 16 feet, with a diameter of six to eight inches. Until some few years ago it was used solely by the Chinese for ceremonial purposes. It may be said that the development in Western Australia in the early days was to a large extent dependent on the sandalwood trade. Since 1845 there have been exported 331,205 tons, valued at £3,061,661. The supply close to the seaboard has long since been exhausted, and the source is now away back in the goldfields district. It thrives in as low a rainfall as eight inches per annum. Lately there has been a development in the distillation of sandalwood oil. The yield of oil from the Western Australian wood is not so heavy as that obtained from *Santalum album*, and the content in essential oil is lower. It is, however, used in Australia for medical purposes, and found to be as efficacious.

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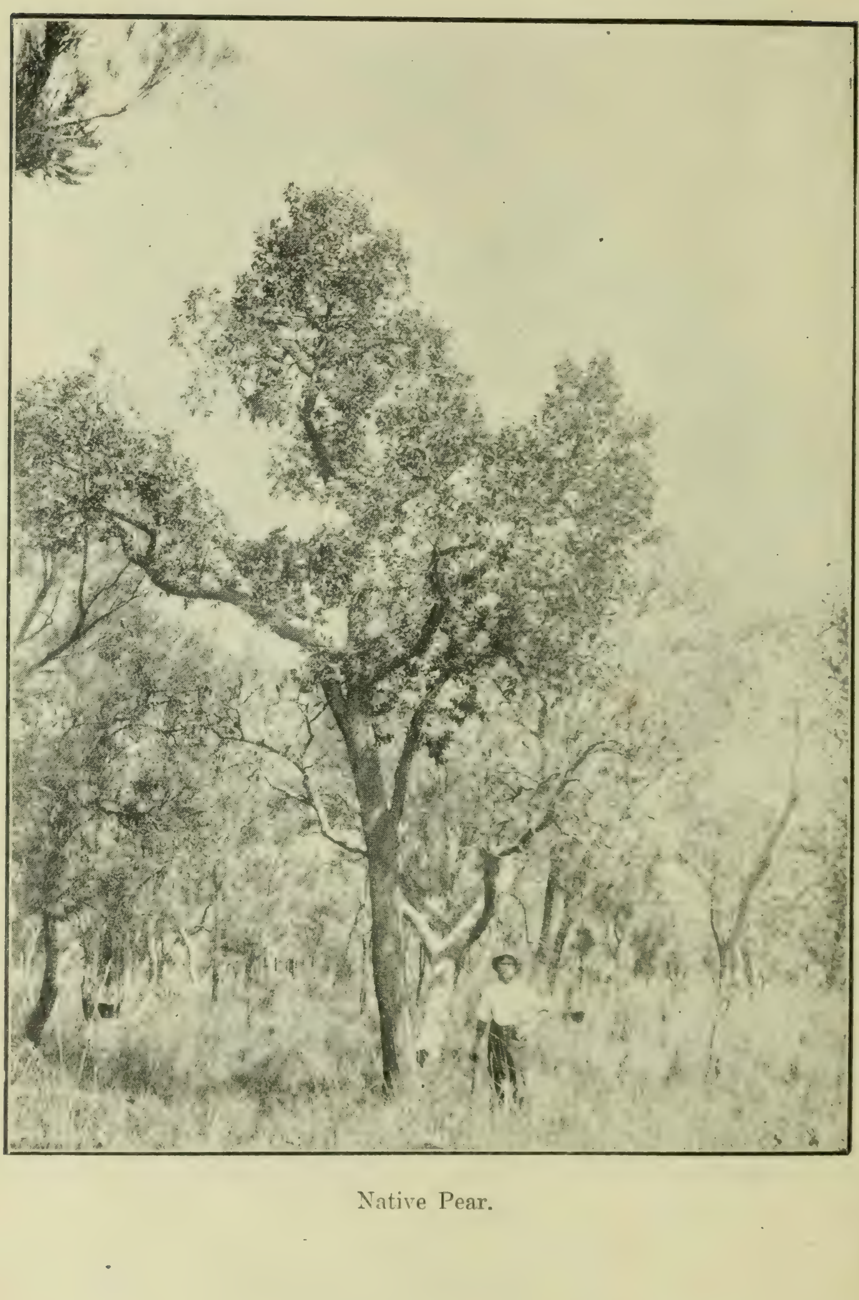
* See further note on page 131.



Native Pear.

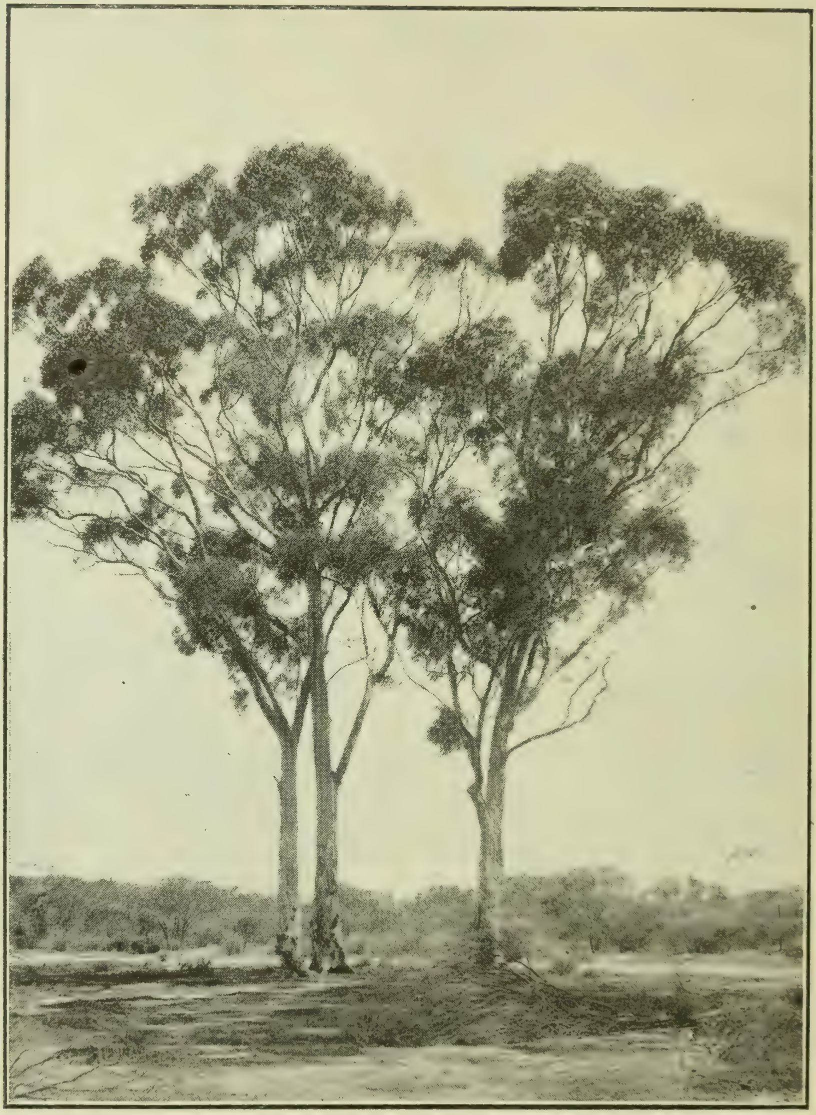
NATIVE PEAR (*Xylomelum occidentale*).

A small tree, attaining a height of 20 to 25 feet, with a short bole, and a diameter of about 12 inches.

Weight per cubic foot (green)—56lbs.
At 12 per cent. moisture—46lbs.
Transverse strength—7,669lbs. per square inch.
Tensile strength—7,000lbs. per square inch.

A tree yielding a most ornamental and dark brown wood, with a beautiful figure. It is light, and makes up into very fine furniture wood ; finished with a wax surface it resembles moire silk.

It is to be found growing all along the sand-plain country, between the Darling Range and the sea coast. Like sheaoak, it suffers very badly from fire, and it is therefore very hard to get in sizes greater than 12 inches in diameter. It is important that thorough fire-protection measures be taken in order to prevent the extinction of this beautiful furniture wood.



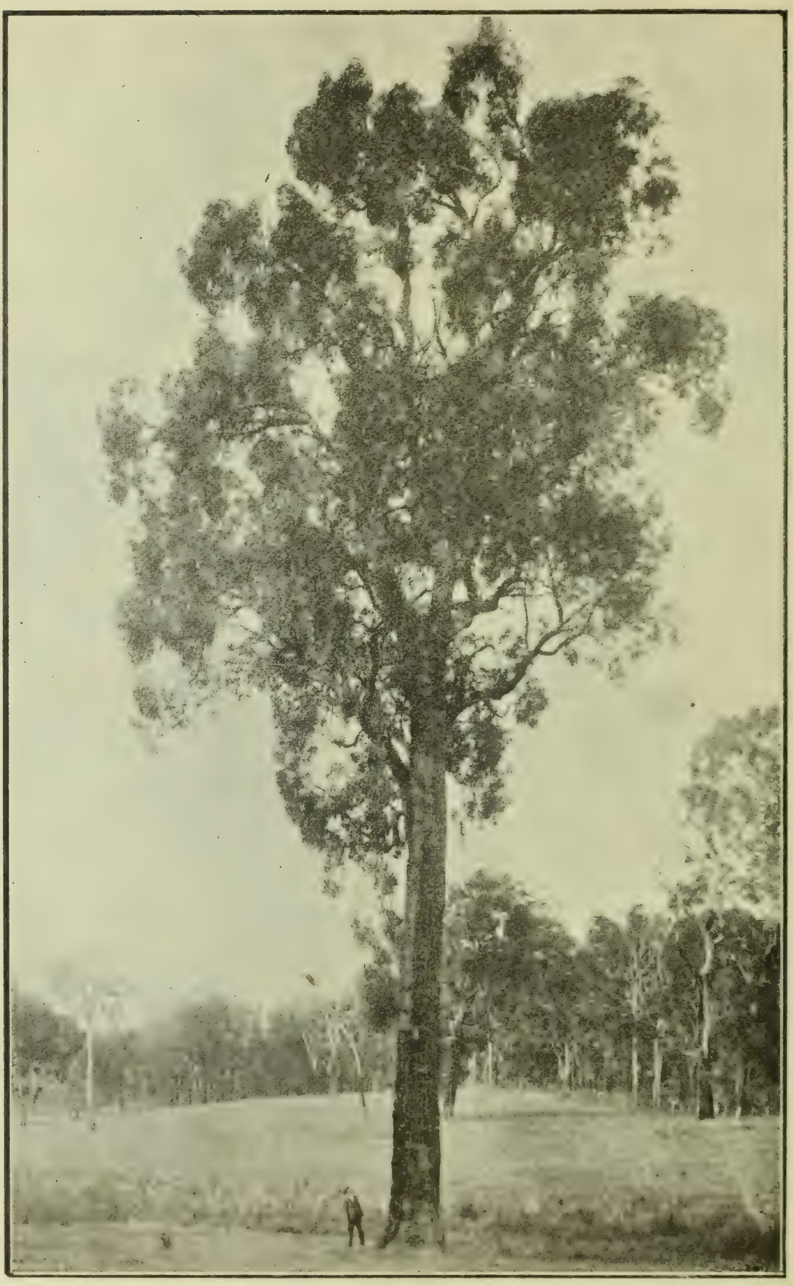
Salmon Gum.

Salmon Gum (*Euc. salmonophloia*).

A tree ranging from 80 to 100 feet in height, with a bole of 40 to 50 et, and about 2½ to 3 feet in diameter.

Weight per cubic foot (green)—70lbs.
At 12 per cent. moisture—66lbs.
Transverse strength—20,100lbs. per square inch.
Tensile strength—19,200lbs. per square inch.

An exceedingly dense wood, the second strongest in Australia. t has up to now been used for mining purposes only. It is questionable hether the goldfields of Western Australia, which have up to date ielded £143,354,051 of gold, would have been developed had it not been or this tree and its sisters Mulga (*Acacia aneura* and *steresophylla*) and imlet (*Euc. salubris*). The region in which it thrives has an average ainfall of 12 inches. Its gleaming salmon-coloured bark makes it he most conspicuous tree of the savannah forest.



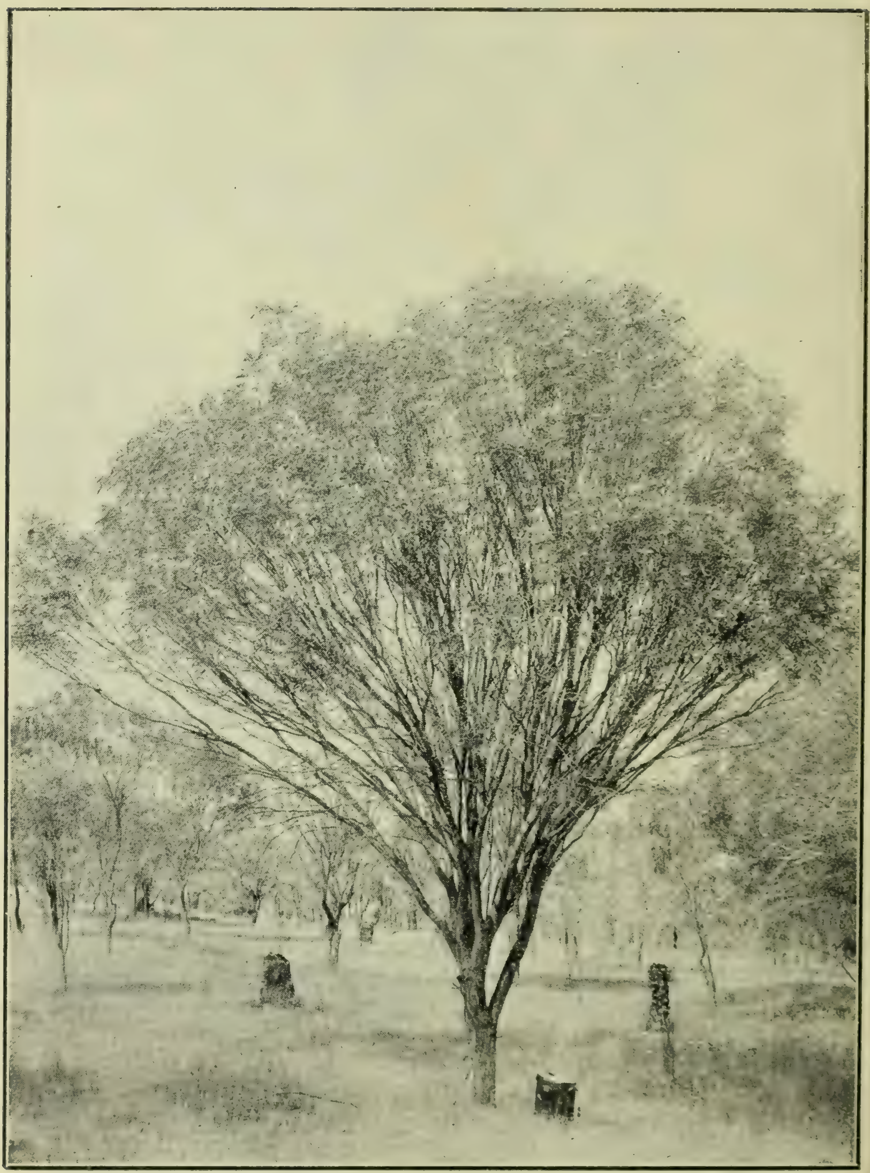
Blackbutt.

BLACKBUTT (*Euc. patens*).

A tree attaining a height up to 100 feet, with a bole 40 to 50 feet, and up to six feet in diameter.

Weight per cubic foot (green)—69lbs.
At 12 per cent. moisture—54lbs.
Transverse strength—14,200lbs. per square inch.
Tensile strength—15,700lbs. per square inch.

About the same weight and strength as jarrah, but a pale yellow-coloured wood. It is not plentiful, but it is to be found in small patches in the gullies and pockets of alluvial soils, between laterite crests of hills. It is useful for many purposes, and particularly for farm implements and railway truck building.



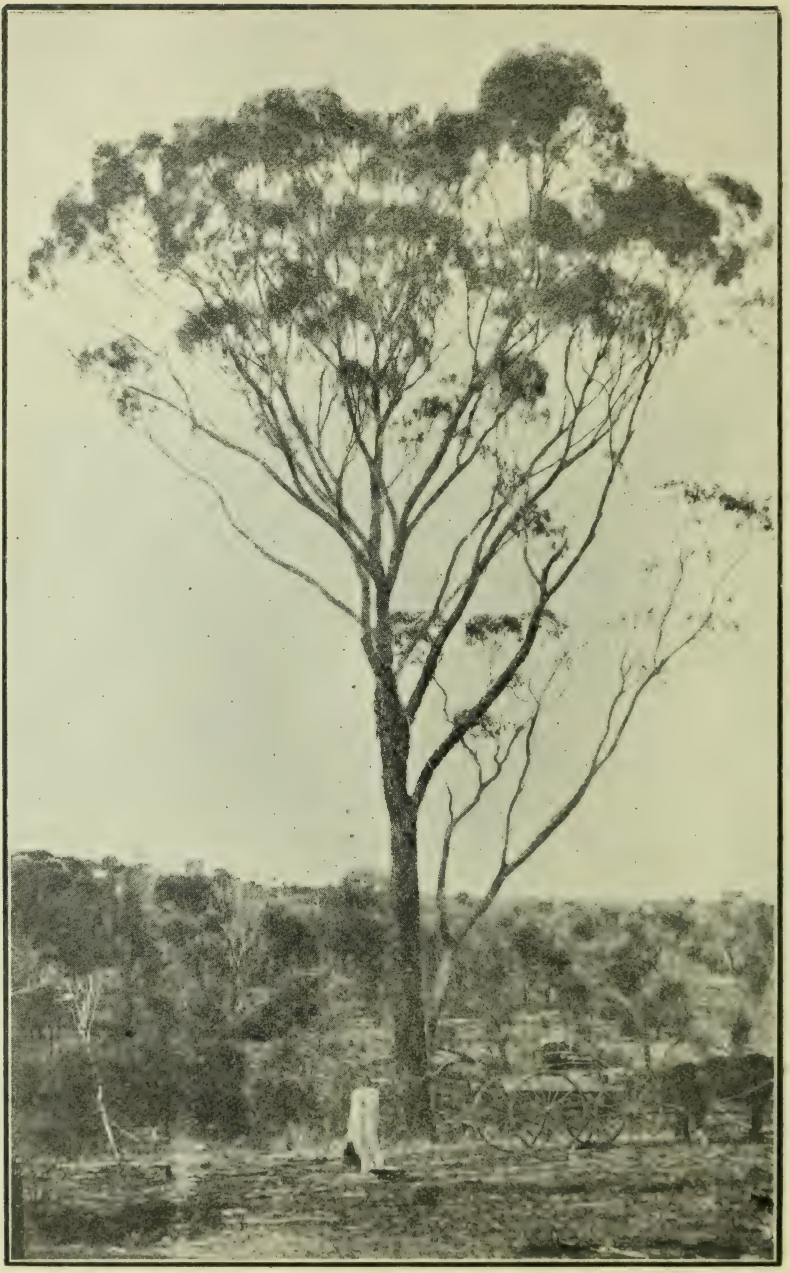
Raspberry Jam.

RASPBERRY JAM (*Acacia acuminata*).

A small tree 15 to 25 feet high, with a short bole, and up to 12 inches in diameter.

Weight per cubic foot (green)—73lbs.
At 12 per cent. moisture—62lbs.
Transverse strength—15,300lbs. per square inch.
Tensile strength—12,000lbs. per square inch.

A fairly heavy wood possessing a remarkably heavy scent resembling that of pressed raspberries. It is very durable indeed ; fence posts 70 years in the ground show no signs of decay. The grain, like its Victorian sister, the Blackwood, is very beautiful, and it is therefore much prized for cabinet work. It is regarded by farmers as an indication of good wheat-growing and sheep-grazing land, and is being rapidly destroyed.



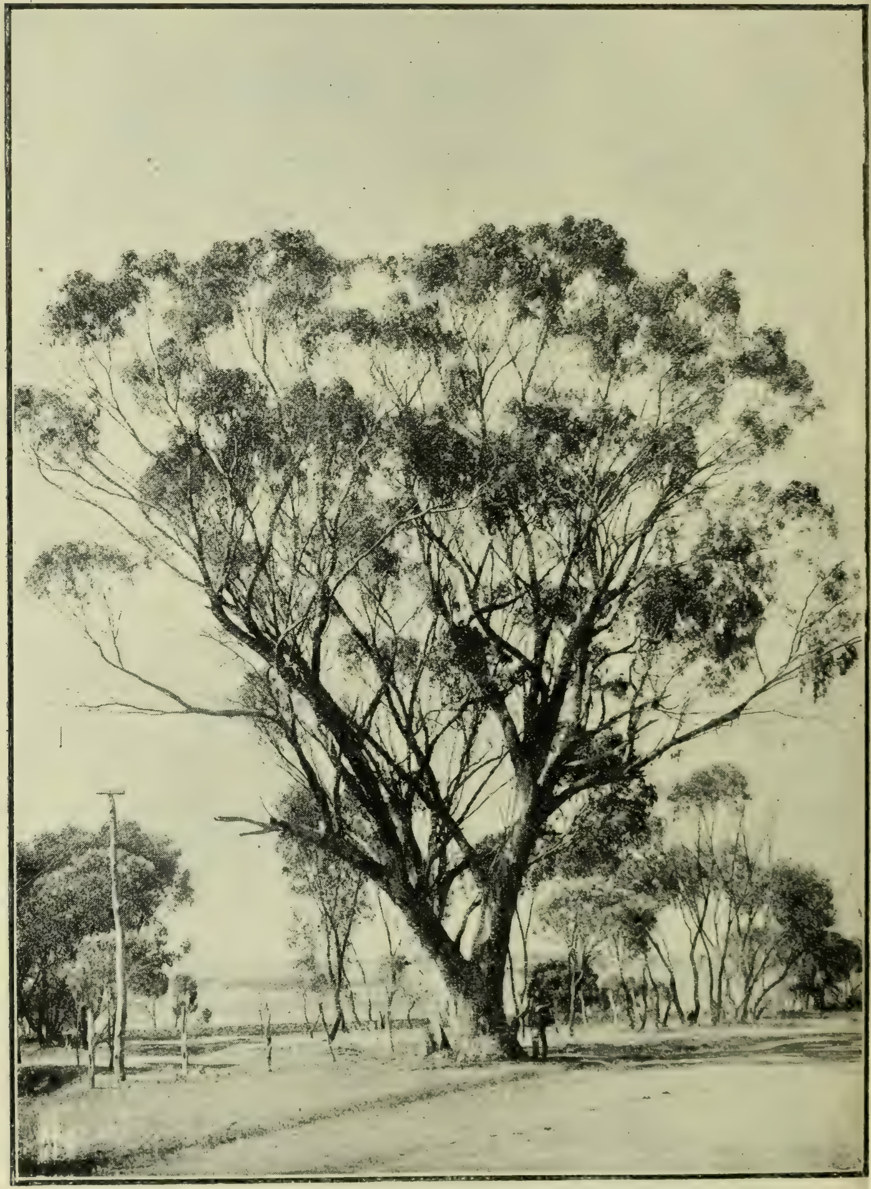
Yate.

YATE (*Euc. cornuta*).

A tree attaining a height of 50 to 60 feet, with a bole of 25 to 35 feet, and a diameter of three feet.

Weight per cubic foot (green)—79lbs.
At 12 per cent. moisture—71lbs.
Transverse strength—16,700lbs. per square inch.
Tensile strength—24,200lbs. per square inch.

This species yields a light-coloured timber of exceptional strength. It is probably the strongest timber in the world, and in one test for tensile strength the breaking load was 17½ tons per square inch, 3½ tons less than that usually specified for wrought iron of ordinary quality. It is used for wheelwright work generally, and is preferred where the strongest shafts for frames of carts are required. It occurs at Busselton, Donnelly River coast, Lake Muir, and Mount Barker district. That it is not used more generally is due to the fact that it is found in open savannah forests at a distance from centres of population.



York Gum.

YORK GUM (*Euc. loxophleba*).

A tree which attains a height of 40 to 60 feet, and a length of bole of 10 to 15 feet, and a diameter of 18 to 24 inches.

Weight per cubic foot (green)—77lbs.
At 12 per cent. moisture—67lbs.
Transverse strength—14,500lbs. per square inch.
Tensile strength—13,000lbs. per square inch.

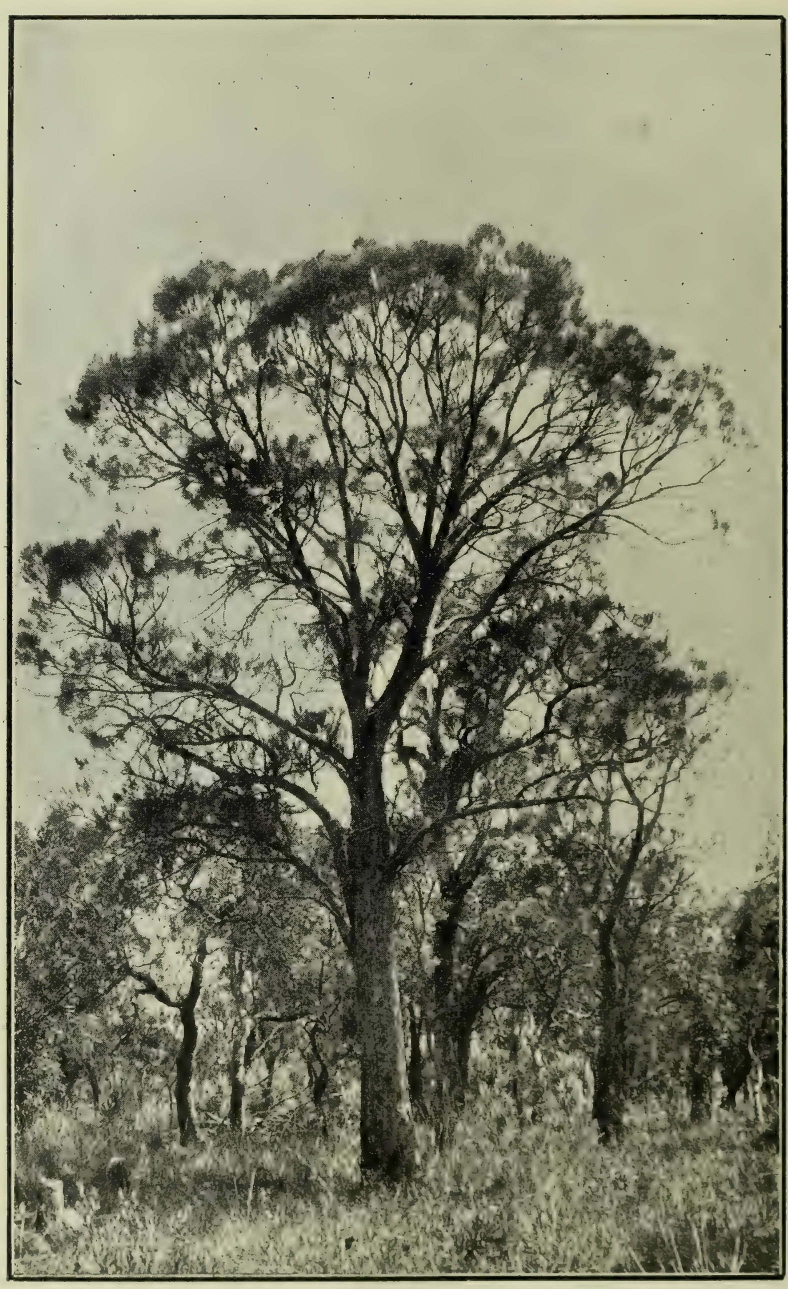
A dense, hard, heavy, wood, with very interlocked grain. The wood is by far the best nave, maul, and mallet wood in Australia, while it may be used very successfully for felloes and other wheelwright and wagon-building purposes. The wood is of a yellow-brown colour, and carries a beautiful figure. It grows in open or savannah forests, and is to be found in the 20-inch rainfall belt. It is most common about Bolgart, Toodyay, Northam, York, Narrogin to Broomehill. Its presence is regarded by farmers as an indication of good agricultural soil for wheat-growing, and also good grazing country for sheep.

RIVER BANKSIA (*Banksia verticillata*).

A tree attaining a height of 50 to 60 feet, with a bole of 15 to 20 feet, and a diameter of two feet six inches.

Weight per cubic foot (green)—59lbs.
At 12 per cent. moisture—35lbs.
Transverse strength—10,300lbs. per square inch.
Tensile strength—8,000lbs. per square inch.

This tree yields a light-coloured timber with a particularly beautiful grain. The medullary rays are wide, so that when cut on the quarter it shows a beautiful oak-like figure, and is much prized for furniture work. It is the lightest of all timbers of the State. It occurs along the side of the larger rivers and streams in the South-West, and is rarely to be found growing far away from running water.



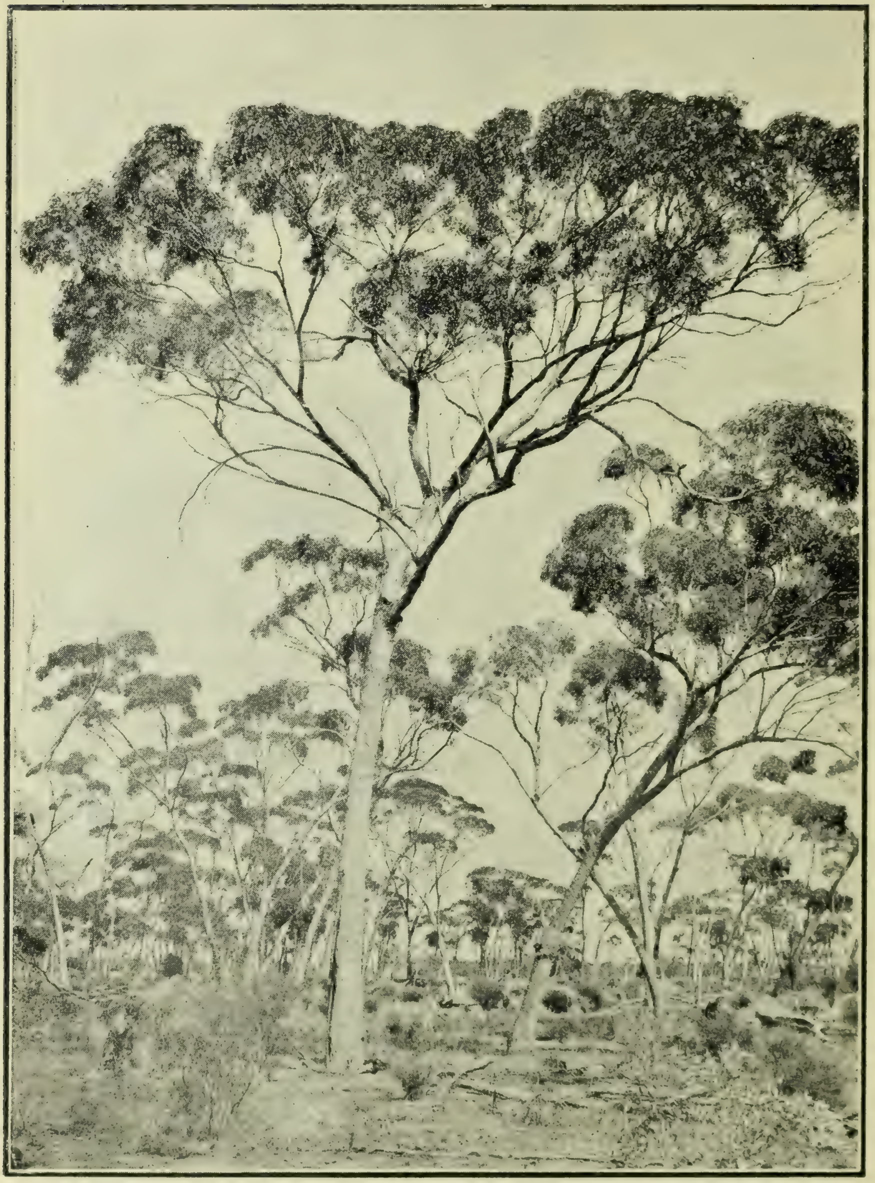
Sheaoak.

SHEAOAK (*Casuarina Fraseriana*).

A tree attaining a height of 40 to 45 feet, with a bole 10 to 15 feet, and a diameter of two feet six inches.

Weight per cubic foot (green)—60lbs.
At 12 per cent. moisture—52lbs.
Transverse strength—12,000lbs. per square inch.
Tensile strength—9,000lbs. per square inch.

A sound wood with broad medullary rays, which show up and make the timber particularly beautiful when cut on the quarter. It takes a good polish and stands up well, and therefore makes an excellent cabinet wood. It makes a good ox yoke. It splits well, and was used almost exclusively in the early days of the colony for roofing shingles. A shingle taken from one of the first-erected houses in Perth (after 83 years' use) was found to be in a splendid state of preservation. Bush fires have played havoc with this species, and it will only be by a sound system of fire control that the future supplies of this valuable timber can be assured. It grows scattered through the length and breadth of the jarrah belt, but is not to be found in the drier regions.



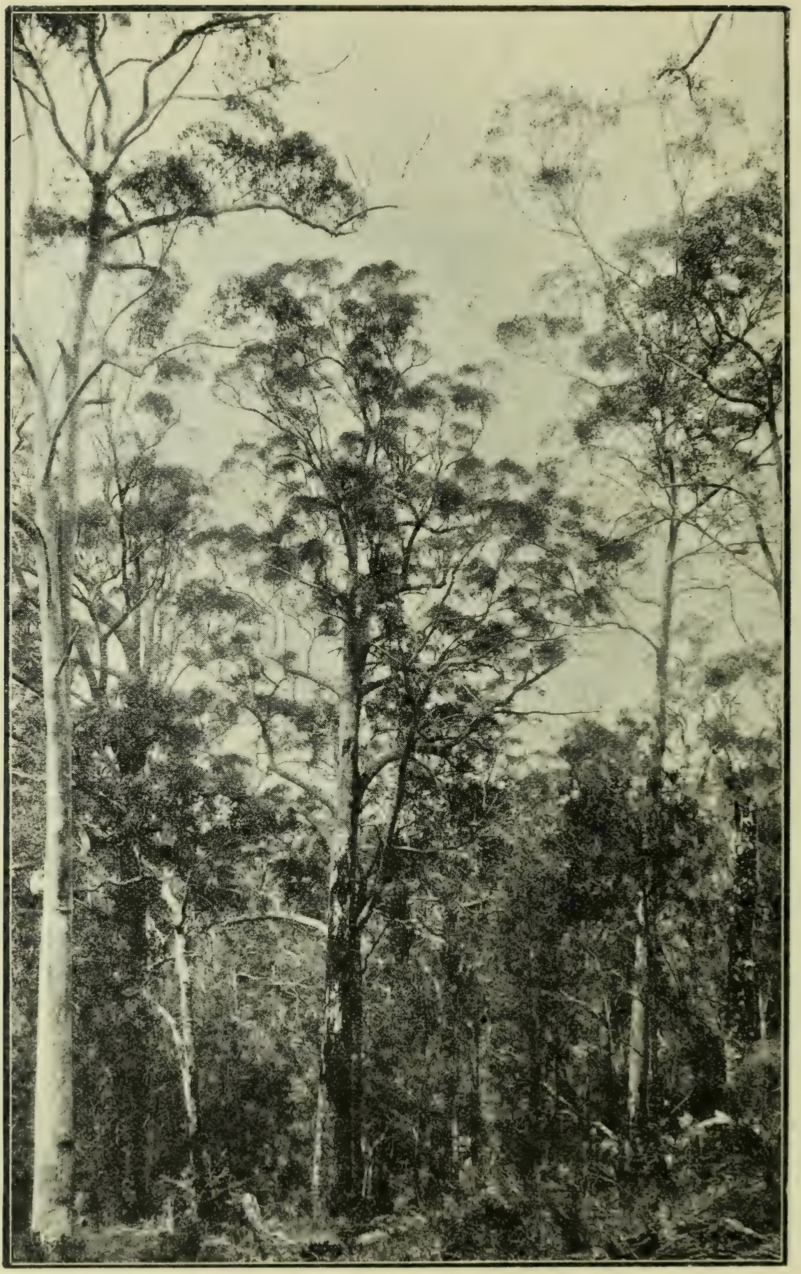
Morrell.

MORRELL (*Euc. longicornis*).

This tree attains a height of 60 to 90 feet, with a bole of 30 to 40 feet, and diameter up to four feet.

Weight per cubic foot (green)—73lbs.
At 12 per cent. moisture—64lbs.
Transverse strength—16,900lbs. per square inch.
Tensile strength—18,000lbs. per square inch.

It is a strong, hard, dense wood, and has an interlocked grain. It is of a dark-brown colour, and is used for wheelwright work, tool handles, etc. It is also used for mining timber. It occurs in the dry country in the rainfall belt of about 10 to 20 inches, and is scattered throughout the length and breadth of country between Three Springs on the North, Katanning on the South, and Southern Cross on the East. It does not grow in dense forests, but occurs in savannah forest formation.



Tingle Tingle.
(The tree on extreme left is a Karri.)

YELLOW TINGLE TINGLE (*Euc. Guilfoylii*).

A tree which grows to the height of about 100 feet, and is three to four feet in diameter. It grows in the same district as the red tingle tingle, but isolated specimens may also be found near Denmark. It forms a lower storey under the red tingle tingle. The timber has not been tested, but from an examination that has been made it appears to be suitable for all purposes for which karri in now used.

RED TINGLE TINGLE (*Euc. Jacksoni*).

A tree which grows up to a height of about 150 feet, and has a diameter of ten to thirteen feet. It occurs between the Bow, Frankland, and Deep Rivers, but does not extend inland very far. It grows down to the water's edge at Nornalup Estuary. Elsewhere it is separated from the sea by sand plain formation. It is usually associated with yellow tingle tingle and marri. Owing to the isolated position of the country in which tingle tingle grows, the timber has not yet been put to any use except fence posts. It appears to have all the qualities necessary to make it good structural timber.

Weight per cubic foot (green)—73lbs.

At 12 per cent. moisture—62lbs.

Transverse strength—14,780lbs. per square inch.

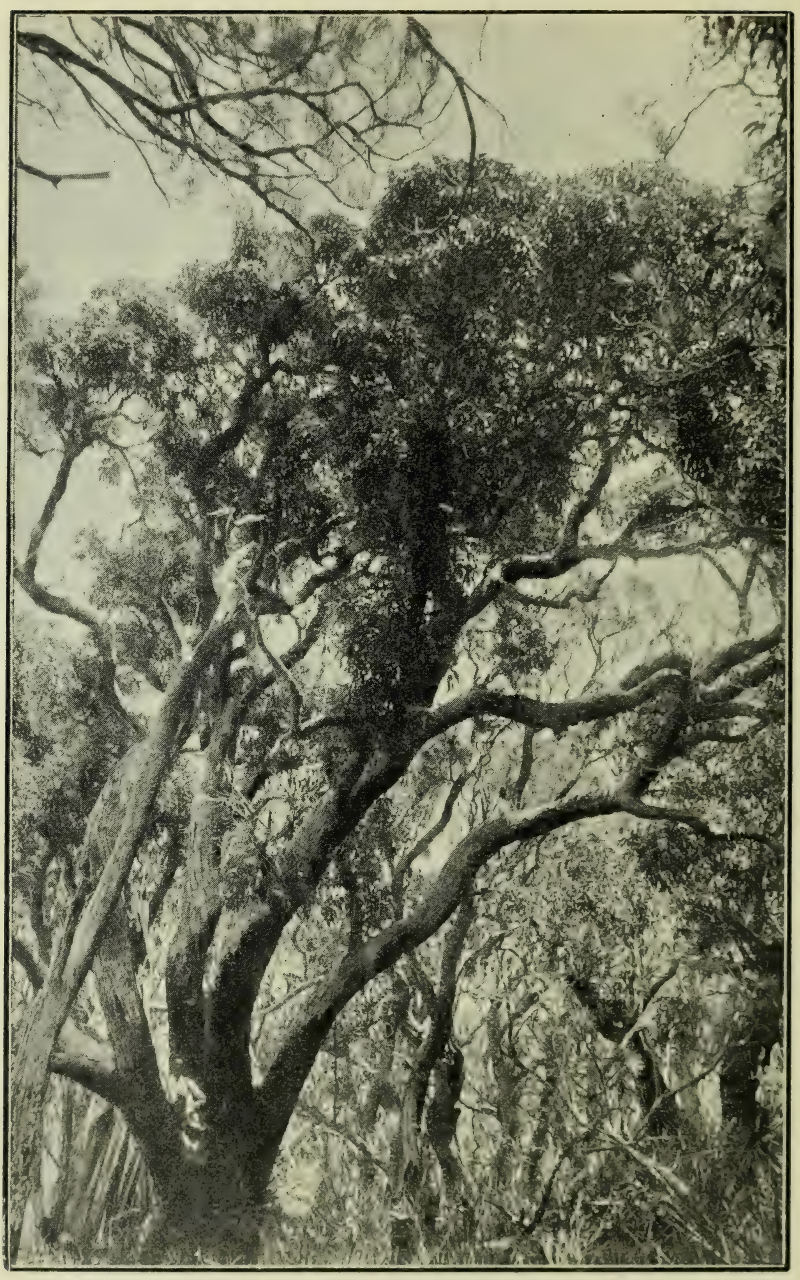
Tensile strength—15,680lbs. per square inch.

MALLETS—BROWN MALLET (*Euc. occidentale var. astringens*); BLUE LEAF MALLET (*Eucalyptus sp. ind.*); SILVER MALLET (*Euc. falcata*); SWAMP MALLET (*Euc. spathulata*).

These four mallets appear chiefly in the savannah country between York and Mount Barker in the South-Eastern District of the State. These trees grow to a height of 50 feet with the diameter of two feet. The bark has been in the past the subject of an extensive export trade, but lack of proper regulation has resulted in its being depleted over very large areas. The bark contains from 36 per cent. to 47 per cent. tannin.

CEDAR (*Agonis juniperiana*).

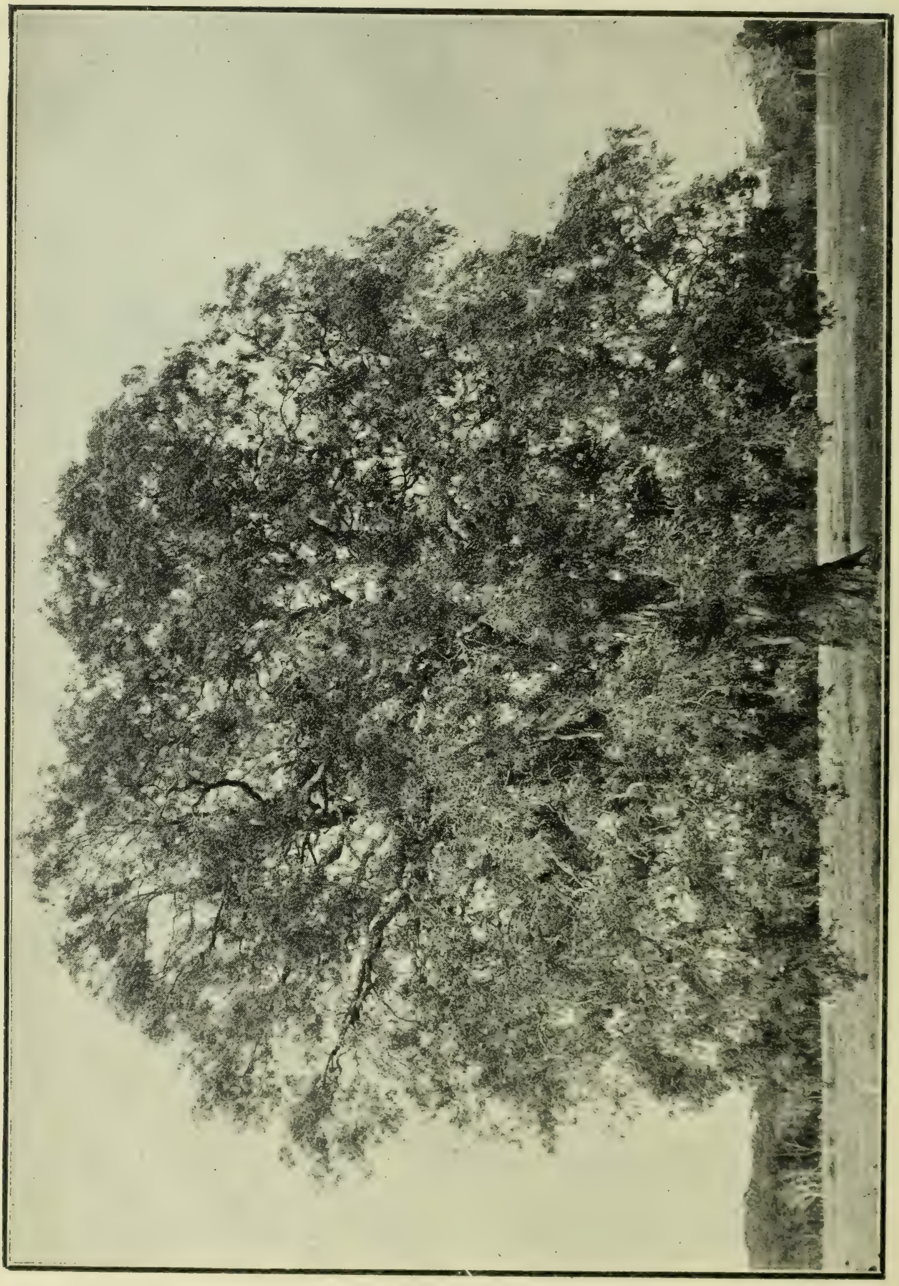
A tree growing to a height of 50 feet, with a diameter of two feet six inches. It is found growing only in the karri country, alongside the running streams and rivers. It is usually associated with river banksia and peppermint. The wood is light brown or yellow in colour. It is very strong and most suitable for axe handles and other uses where hickory or ash is generally used.



Crimson or Scarlet Flowering Gum.

Crimson or Scarlet Flowering Gum (*Euc. ficifolia*).

A tree indigenous to Western Australia only. Found scattered through the limited area in the South-West. It is a particularly handsome tree and both in its native State and in the Eastern States is very much used as an ornamental tree. It is one of the most showy of the eucalypts, as the flowers are of gorgeous colour and stand out very prominently above the dark green foliage. There is in King's Park, Perth, an avenue of these very handsome and attractive trees. It is closely related to, but quite distinct from, *Euc. calophylla*, and does not attain the large proportions of that tree.



W A Peppermint

W.A. PEPPERMINT (*Agonis flexuosa*).

This tree is sometimes known as the willow-myrtle. It attains height of about 60 feet, and has pendant branches. From it exudes kind of kino, and from the foliage an oil with antiseptic properties ay be obtained. As an ornamental and shade tree it has much to ecommend it.

The foregoing list embraces the main trees of Western Australia roducing timber for which a commercial demand exists, and some thers which are not present in sufficient numbers to form the basis f an industry. There are, however, many other trees in the State's oodlands, but the occurrence of most of them is comparatively rare, nd special reference to them is therefore not called for.

Some Goldfields' Trees.

The Central Division of Western Australia, lying between latitudes 26 and 32 degrees south ; bounded on the west by longitude 119 degrees, and on the east by 124 degrees, embraces what is known as the Eastern Goldfields. There are two primary regions of vegetation—the Austin or Murchison type, which extends as far south as Menzies, and the Coolgardie type, which occupies the remainder.

This southern part (which for convenience may be called the Coolgardie district), while including much of the Eremæa or sand-plain type of country, has large forests of Eucalyptus from which the gold mines derive their timber and firewood. The forests extend over the loam and gravel country, and are of the type known as Savannah forests. Eucalyptus trees occur at intervals, with an undergrowth of shrubs and salt bush, or even grass. The trees vary in height from 30 to 80 feet, and are more or less erect with a bare trunk, and spreading branches at the summit. Many trees have a smooth bark, with a collar or ring of rough persistent bark at the base of the trees. The leaves are thick and leathery and hang vertically to reduce evaporation ; the roots spread for a considerable distance, but do not appear to penetrate to any depth.

Shrubs, remarkable for their rigid, tough, or hairy leaves which retard transpiration and reduce the intensity of illumination.—The chief families represented are Myoporaceæ, Sapindaceæ, Proteaceæ, Chenopodiaceæ, and Leguminosæ. The family Myrtaceæ and the section Papilionaceæ of Leguminosæ, so prevalent in other parts of the State, are comparatively scarce in the shrubs here The leading genera are Exemophila, with many beautiful species ; Dodonaea, the "Native Hop," some species of which are used for tanning with good results ; Atriplex, the "Salt bush," which is an article of food for stock, and Cassia, a shrub with large yellow flowers, common throughout the goldfields.

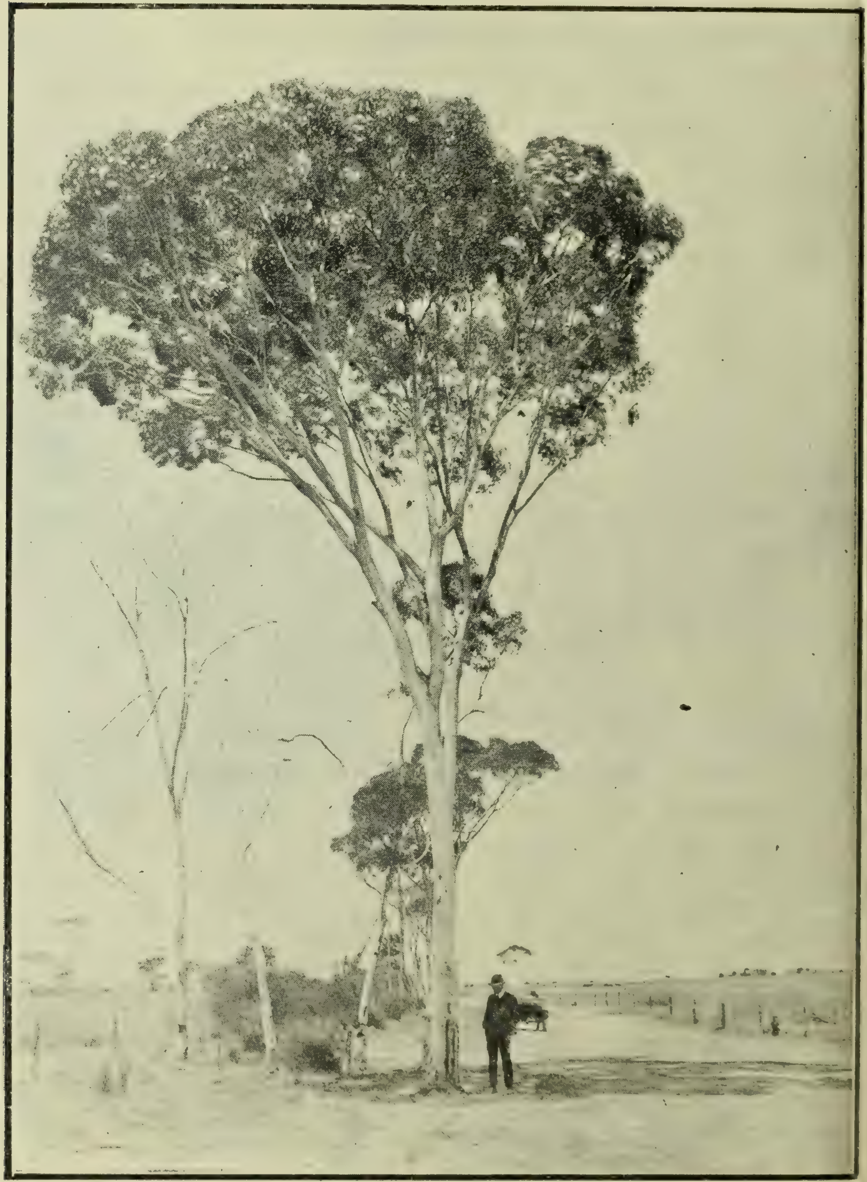
Two other types of country in the Coolgardie district are the sand-plains, and the salt-pans or lakes. The sand-plains occur always on rising ground, the soil consisting of yellow sand and gravel. There are large patches of mallees, notably E. incrassata and E. calycogona, var. gracilis, the "Snap and rattle." Many species of Grevillea and Casuarina (Sheoak) occur. One particularly interesting shrub is the "Water Bush" (Grevillea nematophylla), which is quite common and conspicuous in December with its large pinkish-white flowers. The ots of this tree if taken up, cut into sections and drained, yield water hich is said to be quite sweet, and to have saved many lives in this rid region. Three useful shrubs, now being used satisfactorily for anning purposes, occur on the sand-plains. These are Dodonaæ lobulata, cacia salicina, and Halgania lavandulacea. Dodonaea lobulata, the "Goldfields Hop," is the most common.

The lakes or salt-pans occur in shallow depressions, and sometimes over large areas denuded of vegetation and filled with water in wet easons. Around their margins we see Casuarina, Grevillea, and requently Callitris. The undergrowth is more characteristic, and onsists almost entirely of Chenopodiaceæ, Portulaccaceæ, and Fran-eniaceæ ; the last-named appears to be restricted to this type.

Travelling northwards from Kalgoorlie, in the vicinity of Menzies ve enter a new type of country. This is the Austin or Murchison type. This country is all over 1,000 feet above sea level, and is more or less lat, with low ranges or peaks at intervals, and a few depressions with alt lakes. The soil is gravelly, and is dotted with wide stretches of "Mulga." Several species of Acacia constitute mulga. Of these the hree most common are Pine mulga (A. aneura), Narrow leaf Mulga A. brachystachya), and Broad leaf Mulga (A. craspedocarpa). These rees are all very similar in appearance, varying in height from 8 to 16 eet, with spreading scrub-like branches and a rough black bark. The eaves are silvery grey in colour, and form good camel feed. Mulga is also used in this district for charcoal in gas-production, for firewood, imbering the mines, and in erecting fences and sheds. Eucalypts are xceptionally rare in this district ; there are, however, small isolated lumps generally found in creeks. This region appears to be too arid for the genus.

Following are some of the trees of the Coolgardie Goldfields :—

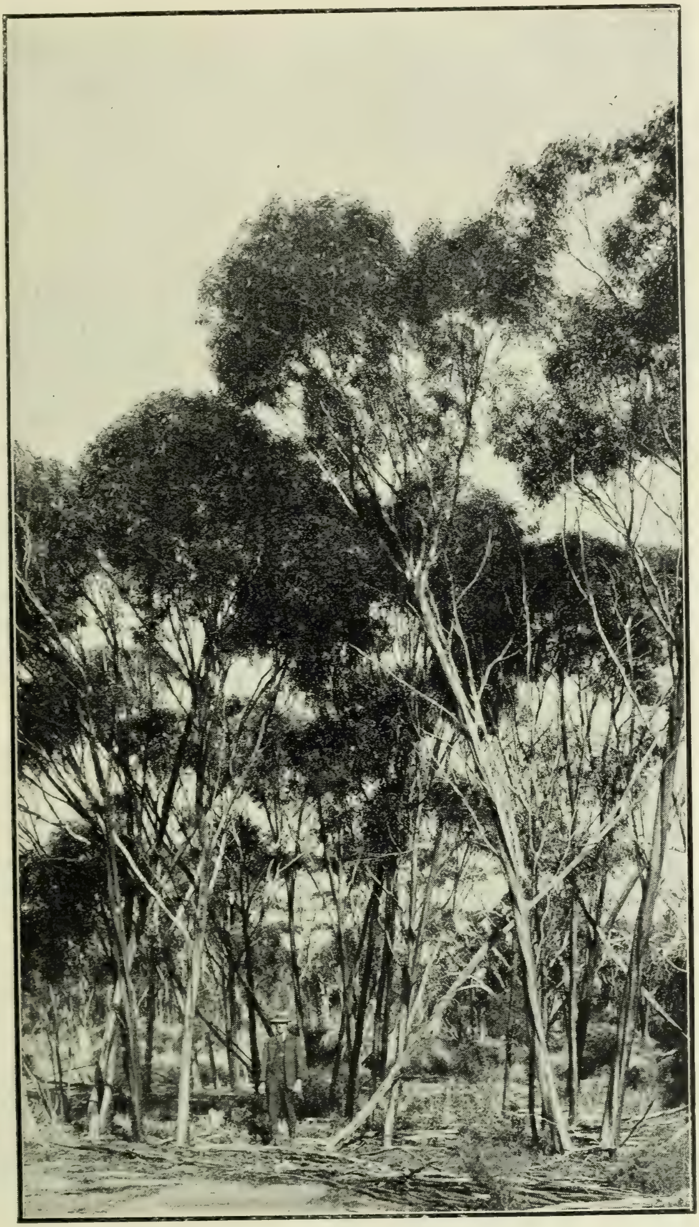
SALMON GUM (*Euc. salmonophloia*).—A tree of 80 to 100 feet wit a long straight trunk, and a smooth bark of a pink or grey colour. Th



Salmon Gum.

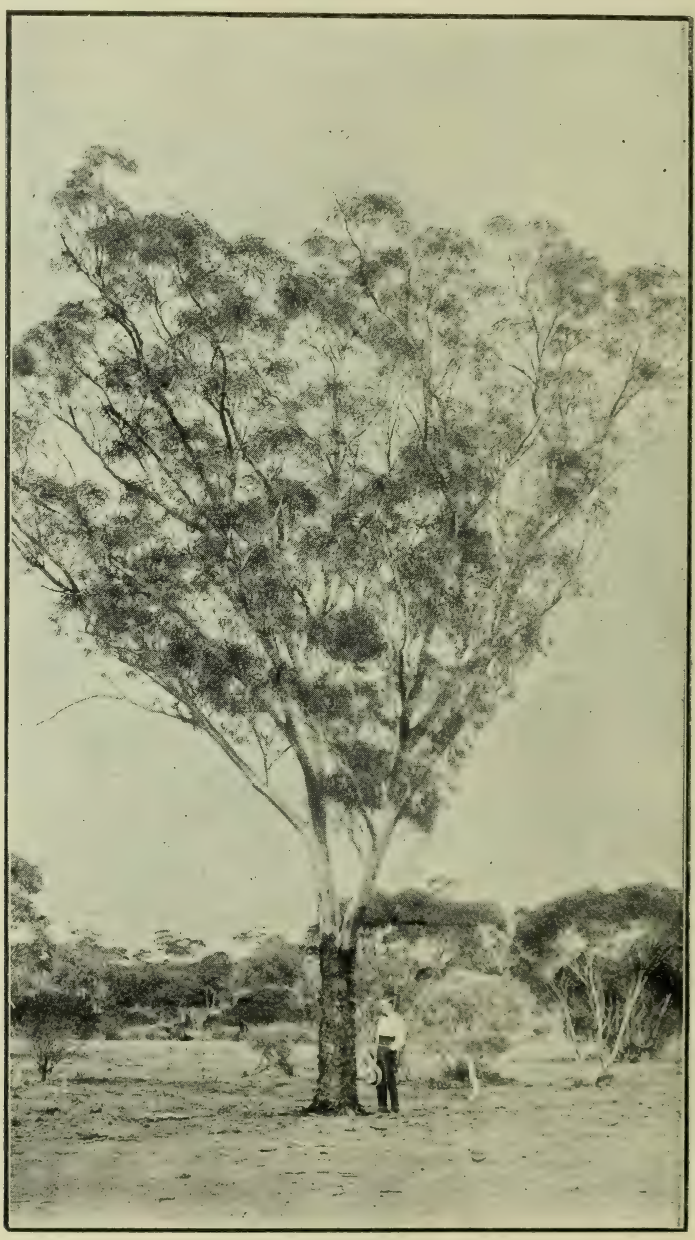
tree has a beautiful crown of dark shining leaves. The timber is th second strongest in Australia. Its chief uses are for timbering the gol mines.

GIMLET (*Euc. salubris*).—A tree generally associated with Salmon um, 60 to 80 feet in height. The trunk is usually slender, and in the young tree spirally twisted or fluted—hence the name. The bark is smooth and of a light brown colour. This tree has a very dense timber, but unfortunately does not attain any great diameter.



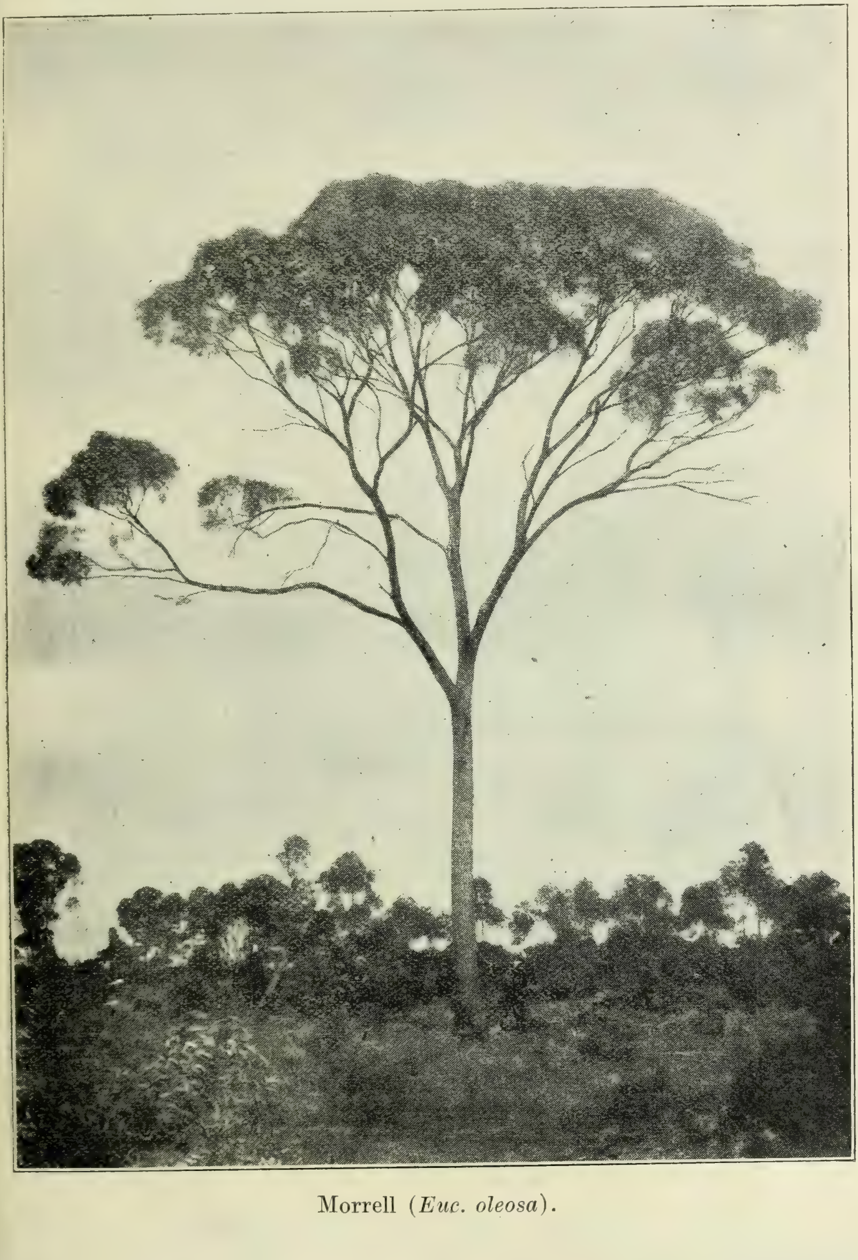
Gimlet.

GOLDFIELDS BLACKBUTT (*Euc. Le Souefii*).—A tree of 30 to 50 feet in height. The bark is of an orange-brown colour, with a collar of flaky black bark at the base of the trunk two to six feet in height, otherwise smooth. The branches are more spreading than in the preceding species, and the leaves of a grey-green colour. The timber is light brown and very dense, but is useless for anything except firewood, as the trees of any size are nearly always eaten by white ants.

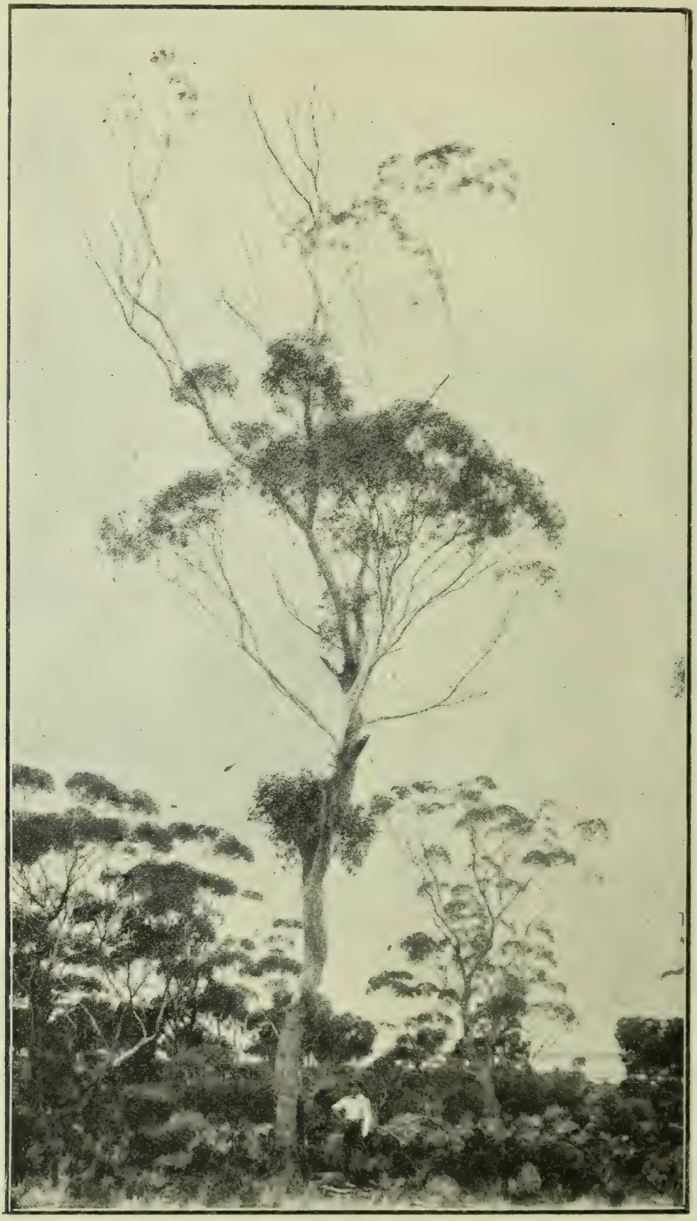


Goldfields Blackbutt.

Morrell (*Euc. longicornis, and E. oleosa*).—These trees, very similar in habit, attain about 50ft. in height, and have widely spreading branches. The bark is grey, rough, and persistent on the trunk and part of the branches, the upper parts having a smooth greenish-brown bark; the leaves are small and shining. The timber is very strong, but the trees do not here attain the size that they do in the Avon District.

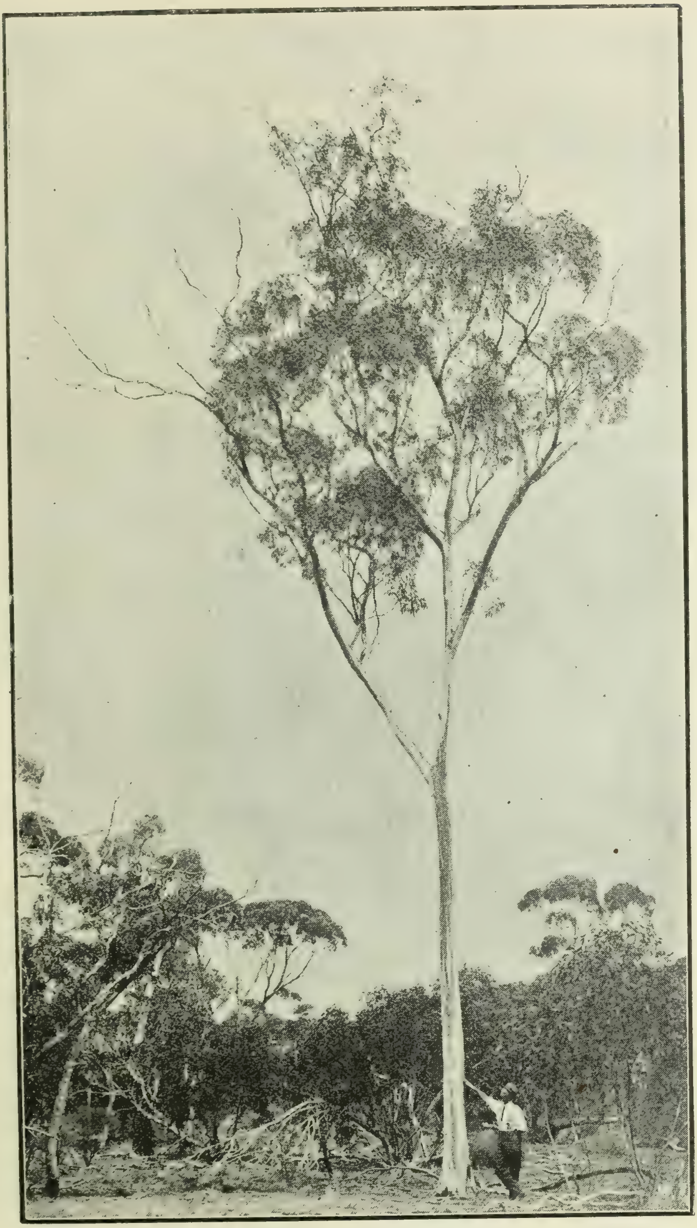


Morrell (*Euc. oleosa*).



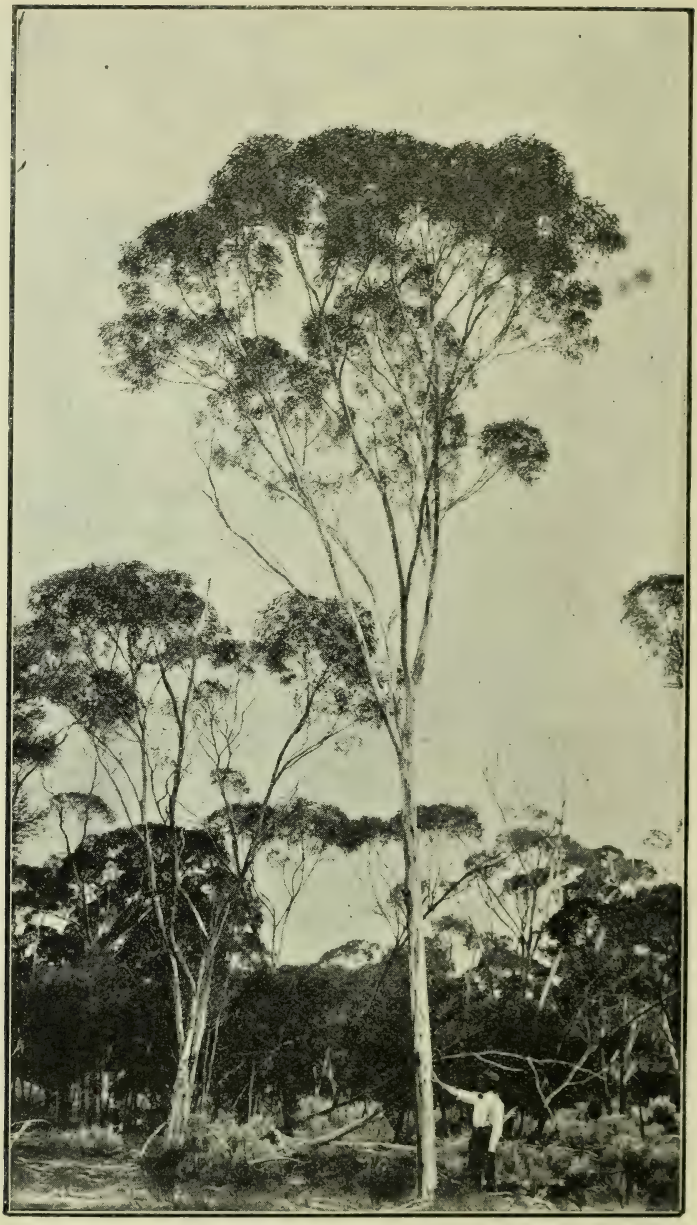
Blackbutt.

Blackbutt (*Eucalyptus Griffithsii*) is quite unlike E. Le Souefii, having a dark grey flaky bark almost over the whole trunk, and is seldom over 35ft. high. In general appearance it is intermediate between Euc. Le Souefii and E. longicornis.



Goldfields Redwood.

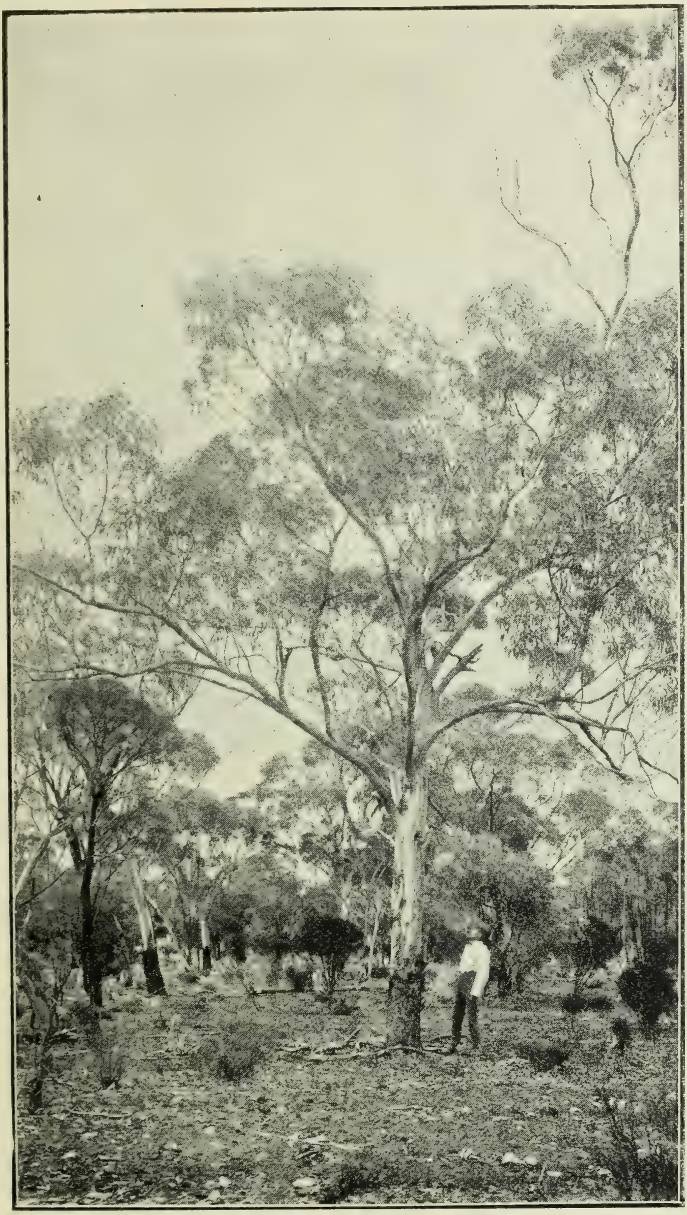
REDWOOD (*Eucalyptus transcontinentalis*).—A tree not unlike the Salmon Gum, except that it is more slender, has a silver-grey bark, yellow flowers, and the young branches and leaves are powdery and a bluish-green colour. The timber is reddish-brown in colour.



Goldfields Whitegum.

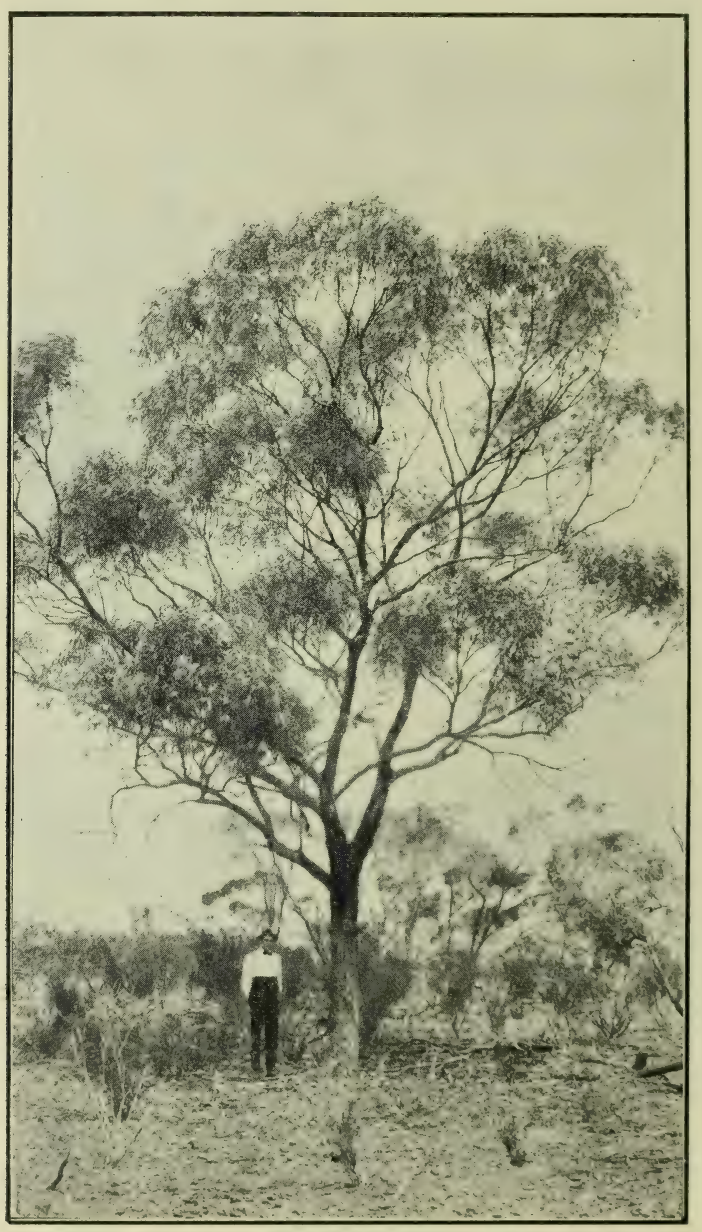
GOLDFIELDS WHITE GUM (*Eucalyptus Flocktoniæ*).—A tree r sembling the "Wandoo" of the Darling Range, but smaller, more slende and a much whiter bark. This tree grows in low lying places in fore of Salmon Gum.

Eucalyptus Stricklandi is a tree of 20 to 30 feet with a light own bark covered with grey flakes of decorticating bark. The branches are very spreading or even drooping. The young branches are powdery-white, the leaves grey-green and often above 6in. long. This tree has very handsome large greenish-yellow flowers.



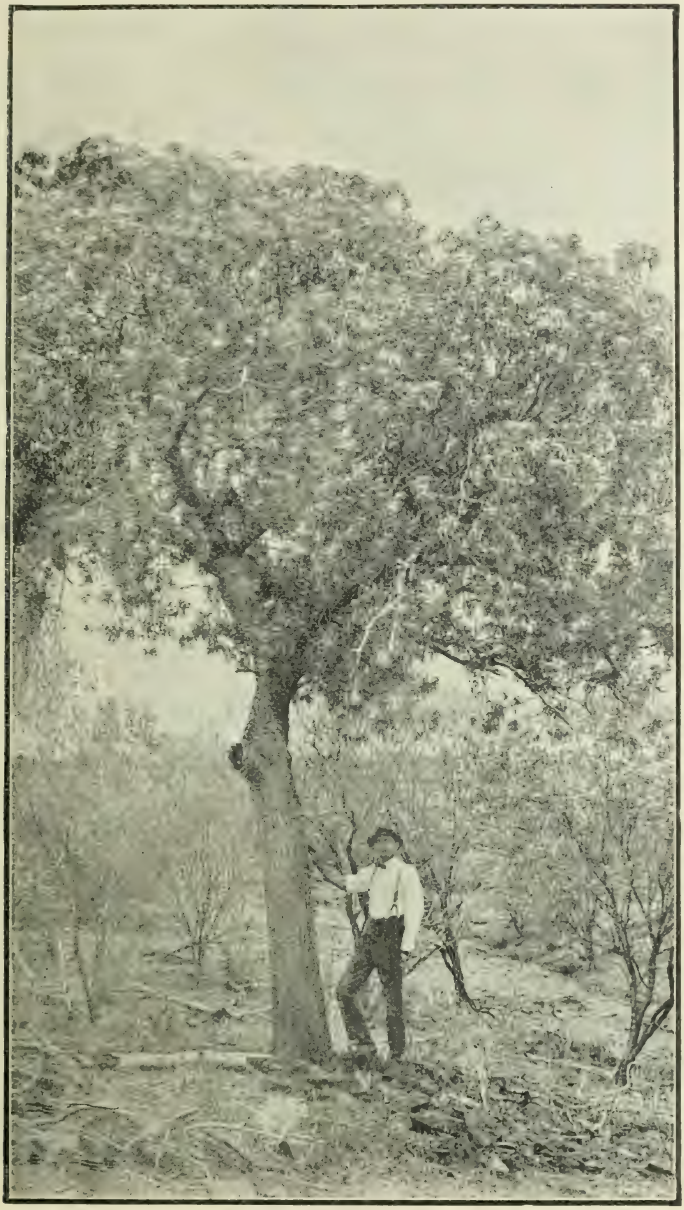
Euc. Stricklandii.

Goldfields Red Flowering Gum (*Eucalyptus torguata*).—Also known as the "Christmas Tree." A small stout tree of 20 to 30ft., with a rough black bark, and always occurs on rising ground in gravelly soil. The flowers are of a bright coral-pink or scarlet, and when the tree is in bloom in December the effect is wonderful. This tree is well worthy of a place in our public gardens.



Goldfields Red Flowering Gum.

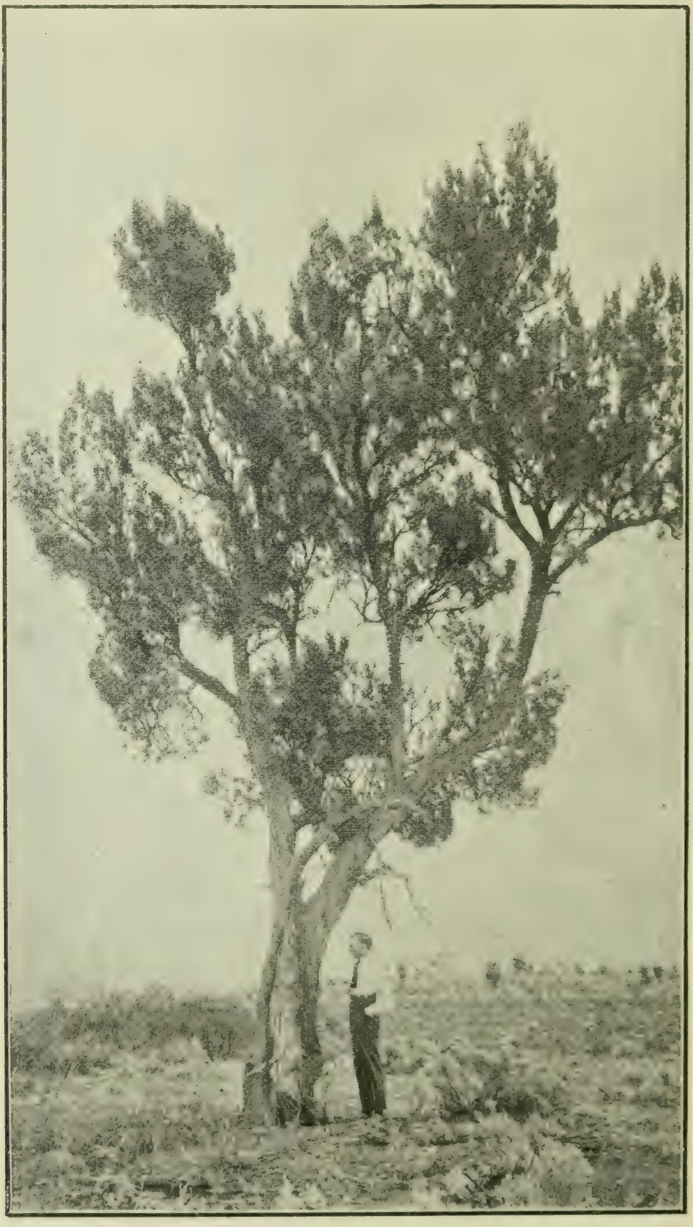
KURRAJONG (*Sterculia Gregorii*).—A tree attaining 25ft. with a hick straight trunk and widely spreading dense branches. The bark s rough and persistent, and of a light-grey colour. The wood is spongy, nd may possess qualities which will make it useful for paper-making.



Kurrajong.

The cambium ring yields a strong fibre. This is a handsome tree and should be used more for shade and ornamental purposes. It is a much more graceful tree and not so symmetrical as the New South Wales Kurrajong which is supposed to beautify our parks.

The Goldfields Pine (*Callitris glauca*) is the largest of the pine shrubs of the goldfields. This tree attains 30ft. in height, and has more or less spreading branches which give it a cedar-like appearance. The leaves are of a bluish-green, the bark almost black and fibrous. This tree is very much like its sister the Rottnest Pine (*Callitris glauca*), and occurs on the margins of salt lakes in open country.



Goldfields Pine.

Sandalwood.

(*Santalum cygnorum.*)

This tree played an important part in the development of the Colony of Western Australia in its earlier decades. In pioneer times the tree was found in the vicinity of Perth, extending over the Darling Ranges into and beyond the farming areas. When markets for agricultural farming produce were, owing to the want of regular communication by ships, few and far between, and ready money in consequence was scarce, sandalwood was of the greatest assistance to farmers in tiding them over difficulties. There was always a ready market for it in the East, and shipments from Fremantle were made with fair regularity in the first half century of the Colony's existence. At present the tree has ceased to exist on the Wheat Belt, and much of the supplies that still leave the State are drawn from the Eastern Goldfields. Sandalwood is found interspersed throughout the mulga belts from which the firewood supplies of the gold mines on the Eastern Goldfields are procured. In those portions of the Gascoyne of which Carnarvon is the port, sandalwood is fairly plentiful, and a considerable quantity is annually sent away.

It exists to-day as a small tree, attaining a height of from 12 feet to 16 feet, with a diameter of from six inches to eight inches. The building of the Great Western Railway brought to light the fact that very considerable belts of sandalwood exist north and south of the line, at points from 80 to 120 miles east of Kalgoorlie. Considerable quantities of the wood are now being obtained from this source, but the extent of the belts has not yet been ascertained. In the earlier decades of the sandalwood trade stems were often found of over a foot in diameter and 12 feet in length, some of these weighing from 3cwt. to 6cwt. In these early days trees were occasionally felled which yielded more than half a ton of marketable timber.

Sandalwood is of parasitic habit, and is found interspersed among other forest trees. The wood is a light yellow in colour and is aromatic. Very little of the wood is used within Western Australia for cabinet or decorative purposes. The bulk of that exported to the East is used for religious and ceremonial purposes, and for the manufacture of glove, jewel, and such-like boxes. The wood yields an oil, and a factory distilling the oil product is in operation in Western Australia. The Western Australian oil as at present distilled differs also from the Indian oil inasmuch as it has a positive refraction. It is extensively used in medical practice in Australia, and has given every satisfaction. The Agent-General is causing therapeutic tests to be made in London with a view to determining the relative values medicinally of the Indian and Western Australian oils. Up to the end of June, 1920, 331,205 tons of sandalwood of a value of £3,061,661 had been exported from Western Australia.

From the figures given it is not difficult to recognise the very important part which sandalwood has played in the development of the Eastern Districts. It would be something akin to a disaster if exploitation were permitted to proceed to such an extent that sandalwood ceased to be an article of export from the State. In order that it may become a permanent source of wealth, the Forests Department has in hand a scheme for the cultivation of sandalwood in some of the old areas which formed its habitat in the earlier days of settlement. The wood is now cut under regulations made under the authority of the Forests Act, 1918.

The cutting of sandalwood is entirely prohibited except under license. Licenses can be obtained from the Conservator of Forests, Perth. If sandalwood on a holding is cut in order to clear land for agricultural purposes, it must be stacked safe from fire and the Conservator of Forests notified, when an inspection may be made. No sandalwood can be marketed until such an inspection has been made, and the royalty of Two pounds per ton is paid.

The following are the Forest Regulations governing this matter :—

51. The cutting of sandalwood except under license granted by the Conservator or any officer acting on his behalf is prohibited.

52. Every license to cut and remove sandalwood shall be issued subject to the payment by the licensee of a royalty of Two pounds per ton cleaned for all sandalwood obtained thereunder.

53. A license under Regulation No. 51 must be held by every person engaged or employed in the cutting, cleaning or removal of sandalwood, and no person shall be so engaged or employed unless he is the holder of a current license.

54. The cutting, pulling or removal of sandalwood from Crown Lands in in the Lyndon, Hardy, Gascoyne, Lyons, Murchison, and Edel Land districts in the North-West Division of the State, except for distillation purposes within the State, is hereby prohibited. Any person committing a breach of this regulation shall be liable on conviction to a penalty not exceeding fifty pounds.

55. No sandalwood shall be loaded into railway or tramway wagons or on board ship unless it has been inspected by an officer of the department, and a certificate issued by him that such inspection has been made and the royalty is paid.

The growing importance of the sandalwood oil industry has rendered it advisable to take steps for its protection and therefore for its permanence. With this object in view, a large area of sandalwood bearing country in the Gascoyne District has been reserved for oil purposes only ; that is, no cutting of sandalwood will be allowed on the reserved area unless for the purpose of oil extraction in factories within the State. At the end of 1920 one sandalwood factory was in operation in the Metropolitan Area and another was being established also in the Metropolitan Area.

WHAT THE CHINESE DO WITH SANDALWOOD.

It is generally understood that most of the sandalwood imported from Western Australia into China is used for "ceremonial purposes," *i.e.*, as joss-sticks in religious ritual. Much of it certainly is burned in that way, but a great deal finds useful and ornamental purposes in small boxes, fans, napkin rings, and a host of other small articles. Sandalwood is valuable, and the Chinese who work it up do not permit themselves to indulge in waste. Even the dust from the floor of a factory where the timber is used is swept up and made use of. For the making of joss-sticks the sandalwood is ground to a fine powder, the debris from box-making and carving being also utilised by the worker who produces the powder. This sandal-flour is then mixed into a paste with some mucilaginous medium. The common joss-stick—the one used by the poor or penurious among the faithful—is made up of a slip of bamboo about eleven or twelve inches in length, and having a thickness about equal to the lead of an ordinary black lead pencil. The paste referred to is applied on about seven inches of the bamboo slip, the rest of it forming a handle for holding or carrying the stick. They are also produced by painting the upper part of the slip with an adhesive mixture and then dipping or rolling in the sandalwood flour. When a match is applied to the upper end of the stick it becomes alight, and the flame having been blown out, the coated bamboo portion continues to smoulder until the uncoated part is reached, giving off an aromatic smoke all the time. These small joss-sticks are sold in China for about 40 cents per bundle of 50 or 60. Joss-sticks are of many sizes. Some are almost two feet in length, with the coated portion a good half inch in diameter, these larger sizes being priced up to 5 cents per stick. These are used by the more affluent worshippers, and by those who consider that the more smoke they make the more likely are their petitions to be heard.

A variation of the joss-stick is in the form of curls or coils made of sandal dust and some matrix and not unlike thin blasting fuse in appearance. This is made in Canton and sold in boxes of half a dozen yards or so at the remarkably low figure of 10 cents a box.

Chinese skill and patience are finely represented in the small boxes made from the Western Australian timber. Fruits, leaves, and flowers are reproduced with marvellous fidelity and in curious but effective combination of high and low relief. And the prices charged in China indicate that the Chinese artist has not yet been bitten by the loathly microbe of "get-rich-quick." A box, six inches square, and fully carved all over except on the bottom, which by the way is not of sandalwood, is priced by its maker at 4 dollars, or, say, 12s. sterling. A smaller box, showing domestic scenes, with serrated tracery on its sides, is marked at 2 dollars, while a card-case (lady's size) carved all over, bears 1 dollar as its price at the factory or studio. A fan with the lower portion of its leaves of carved sandalwood and the upper part covered with silk embroidered in colours with representations of birds and flowers is ticketed at 1·60 dollars, while one all of sandalwood and carved all over in pierced work is priced at 60 cents. Sandalwood even enters into the Chinese scheme of education. Small boxes beautifully carved and filled with carved blocks, all of sandalwood, and used as stencils, convey ideas of form to the young Celestial, and by way of helping the box is accompanied by a printed book of instructions with illustrations, and the whole outfit is valued by its designer at 30 cents. One is not surprised to learn that the ingenious Chinese have turned sandalwood to good purpose in the way of adornment for the fair ones of their own or their neighbour's household. Necklaces of sandalwood beads are to be had by any who wish, and in all degrees of elaboration. The beads are not sandalwood nuts, but are made of the wood itself, and each is delicately carved. Such a necklace, about five feet in length, containing over 100 sandal beads, with pendants of other substances, and fit to adorn an Eastern princess or a picture-show star, may be had from its maker for the amazingly low sum of 3 dollars.

In its native home, beyond the production of oil, very little use has been found for sandalwood ; a little inlay work measures the sphere of its usefulness in Western Australia. But in China it enters largely into the arts, and by all classes is highly esteemed.

Coolibah.

The people of the settled portions of Western Australia are so accustomed to hear the phrase "The possibilities of our great State are as yet only known to a small degree," that it has begun to lose a good deal of its significance. Even the man in the street is beginning to say "Why don't you come at once to hard facts, instead of talking large and inconclusive generalities?" But, after all is said and done, the fact remains that much of the native wealth of the State has still to be discovered. Now and again some facts relating to a hitherto unknown or little known indigenous product are made public, and the people of the State become aware that the basis of a new industry—it may be great or it may be small—has been found. It is in the North-West, however, that the richest fields of discovery and exploitation remain to be traversed, and this is true whether it has reference to the vegetable or the mineral kingdom. The jarrah and karri of the South-West portion has so occupied public attention since the very earliest days of settlement that little consideration has been given to trees elsewhere. In the North-West, for example, cypress pine exists, but so far no systematic effort has been made to estimate the quantity that is to be had or the localities in which it is to be found. Then there are a score of tropical eucalypts, all of them having useful qualities of their own, some in the matter of the timber and others for the active agents hidden in their barks, leaves, and twigs. One of these eucalypts is Coolibah, a eucalypt the botanical name of which has not yet been determined.

So far the commercial value of the tree seems to lie wholly in the quality of its wood. It is probably the densest and hardest of the eucalypt family, and the most difficult to work. But these very qualities which so sharply differentiate it from its brethren meet some very important requirements in industrial life, and these requirements are of such consequence that, if the timber can be secured in sufficient quantities and at reasonable cost at the port of shipment, a ready market awaits it in various industrial centres in Great Britain and elsewhere. But, before particularising some of the industrial needs which the coolibah can fill, mention must be made of some other of its qualities which in the past have highly recommended it to the aboriginal inhabitants of Western Australia. Mr. K. H. Bennett notes this tree as possessing water-yielding roots. The lateral roots, he says, are lifted by the natives with sharp-pointed sticks or their spears to the surface from about a foot or less depth, and to a distance of fifteen or more feet from the tree, the over lying earth, when necessary, being removed by wooden shovels: the root is then cut into pieces of about eighteeen inches length, and the bark peeled off ; if the water, on placing these fragments vertically, does not at once commence to ooze out spontaneously, the process is expedited by blowing vigorously at one of the ends of the root-pieces ; roots of the size of a man's wrist are the best for this operation. Mr. Bennett obtained in most favourable cases by these means a quart-pot full of water in half an hour, and found it beautifully clear, cool, and free from any unpleasant taste. Roots from depressions in the ground yield the fluid more copiously. Main-roots near the stem are not sufficiently porous for obtaining water therefrom. But the blacks not only find the coolibah of value as a yielder of water. They also turn it to use as a provider of food. Roth, an investigator (in a Bulletin on N.Q. Ethnography), writes : "In the North-West districts, especially in large water holes, I have often watched the process of fish poisoning, or rather stupefying. The whole camp may co-operate and will start throwing the leafy boles and branches in first thing in the morning. During the day the water becomes darker and darker and strongly smelling, until by the following morning at sunrise, when it is quite black, the fish all lie panting on the surface and are easily caught. And Mr. E. Palmer, another investigator, records that the inside bark is obtained and, after heating, is used as a poultice for snake bites.

The extreme hardness and weight of the wood mark it out as particularly suitable for certain special purposes. Even if it grew in fairly close forests such as do jarrah and karri, coolibah as a timber for ordinary constructional purposes could scarcely compete with the woods named, for its extreme hardness and the difficulty of working it would militate against it if other wood equally suitable for the purpose and less difficult to work were available. It would seem that the sphere that may be filled by coolibah is similar to that now occupied by lignum vitae. As a substitute for or competitor with lignum vitae, coolibah would seem to have a useful and profitable future marked out for it. For certain purposes connected with machinery it has been found to fulfil the duties usually assigned to lignum vitae and to be in every way equal to that wood. For shaft bearings and bushes lignum vitae is extensively used, but coolibah is equally capable of doing the work. The Metropolitan Water Supply Department undertook to experiment with coolibah for bushes in sewerage pumps and similar uses, and the Department quite recently reported "the experience of this Department has been that the use of local hardwood in lieu of imported lignum vitae has proved that it is quite equal to the imported wood and is giving every satisfaction." This testimony is valuable, and it only confirms what has been already demonstrated in regard to the use of coolibah in machinery of quite a different type. The stern tube of steamships, for example, at the outer end where the tail shaft passes through, has to be lined with some material that is wear-resisting and also possesses the qualities of resilience and toughness. It is necessary that these qualities should be present in any material used. Metal for such a purpose is scarcely suited, for in heavy weather when the propellers are momentarily out of the water, and the engines may race, the wear and tear is abnormal, and it has been found that only timbers of the greatest density meet the requirements of the case. As stern tube lining coolibah has been tried and has given every satisfaction.

In one respect at least coolibah is superior to lignum vitae, for it is a heavier wood, and weight for certain purposes has its advantages. Lignum vitae dry weighs 73lbs. per cubic foot, while coolibah commercially dried, that is at 16 per cent. moisture, weighs 82lbs. per cubic foot. The ultimate strength of lignum vitae tested as a beam is 12,000lbs. per square inch, while in the case of coolibah the figure obtained is 14,460 lbs. per square inch. Again, the tensile strength of lignum vitae is 11,000lbs., while that of coolibah is 13,470lbs. So far as hardness is concerned, it requires a static load of 12,540lbs. to produce an indentation of one-twentieth inch in coolibah, while in the case of lignum vitae, a static load of 6,600lbs. produces an indentation of one-tenth of an inch.

When Mr. Lane-Poole, the Conservator of Forests, was in London as one of the Australian delegates of the British Empire Forestry Conference, he had a number of interviews and communications with firms using lignum vitae for sporting purposes, such as bowling green bowls. Some of these firms had heard of coolibah earlier and had made efforts to secure samples of it for experimental purposes, but failed. All of them were much impressed by a sample bowl which Mr. Lane-Poole submitted to them, but, before giving finality to the matter, the whole of them desired to have logs or pieces of timber for the purpose of the firm's examination. One firm mentioned that its requirements of such woods would probably run to 300 tons a year. It would seem, therefore, that there is a market abroad for one more of the State's natural products. All that remains to be done is for public or private enterprise to take the matter up as a commercial proposition.

Christmas Tree.

One of the most spectacular vegetable growths to be found in the Australian bush is the *Nuytsia floribunda* of Western Australia, known generally as the Christmas Tree, and by the aborigines called the Fire Tree. Everyone in Western Australia is familiar with its golden glory, and it has been an object of admiration to all beholders since the days of earliest settlement. Its vernacular name has reference to the time at which it flowers, and at that period it appears to be a mass of golden fire. But the beauty of its flower appears to be the only quality which recommends it to public notice. Its wood, from a commercial point of view, is valueless, and for the reason that it is a true parasite it does not permit of transplanting or cultivation except in circumstances which are not always possible with those who would like to use it as an ornamental tree. It exudes a clear yellow gum which may prove valuable.

The flowers are in erect clusters, sometimes two feet or three feet in length. The tree, as has been said, is parasitical in nature, as it grows only near other trees which act as its hosts, these trees being mostly banksia and jarrah, and the natural habitat is almost wholly confined to the flats lying between the hills and the sea-coast. For many years the precise nature of its parasitism was not clearly understood. It was thought that all that the tree required for its comfortable existence was that it should be in the neighbourhood of certain trees, but recent investigations have proved beyond a doubt that this theory was inadequate, and does not by any means measure the true extent of the parasitic habits of Nuytsia.

Mr. D. A. Herbert, Government Botanist and Pathologist, in the end of 1918 and beginning of 1919, made close investigation into the habits of the tree, and the result of his inquiries was embodied in a paper which he read before the Royal Society of Western Australia. He demonstrated that proximity to hosts does not sufficiently explain the nature of the tree's parasitism, but that, as a matter of fact, it sends out long underground shoots which attach themselves to the spreading roots of its host trees and feed upon them. It has thus been established that Nuytsia is a parasite of the first order. In the course of his paper Mr. Herbert says :—

Roots are given off from the long underground stems and when they are traced out they are found to branch repeatedly, finally giving rise to long white fleshy roots up to about a quarter of an inch in diameter, and from these branch smaller white and very fragile roots. It is probably on account of the extremely fragile nature of these roots that the parasitic nature of the Christmas tree has not actually been discovered previously. When a white root comes into contact with the root of another plant, a fleshy outgrowth starts to develop. Two white fleshy arms start to grow round the attacked root in opposite directions from the point of contact. Ultimately the two arms meet on the other side of the root and fuse so that an unbroken fleshy ring encircles the host. On the inner side of this fleshy ring at the points of contact arise the haustoria or suckers, so that it may for convenience be called the haustoriogen. The haustoria are formed on the inner side of the fleshy arms before the ring is complete. The haustoriogen in section is found to contain a very small vascular bundle, which is composed of simple parenchymatous tissue. The haustoria are small tongue-like masses of parenchymatous tissues, and when they pierce the cortex of the host plant, they appear to derive all food materials they obtain from it by simple osmosis. There is no fusion of the cells of host and parasite. The haustoria never go in as far as the wood. The wood is the channel of transference of water containing the organic constituents of plant life, and the cortex and base the means of transference of elaborated nitrogenous and non-nitrogenous organic food materials. The conclusion is that the main object of the parasitism of Nuytsia is to obtain an additional supply of organic materials, including nitrogenous substances.

Mr. Herbert's discovery has decided a question that has long been a subject of debate. It seems, however, that once Chirstmas Tree is thoroughly established and well grown, the immediate presence of host trees is not necessary to its continued life and health. Instances are known in the agricultural areas of isolated Nuytsia having been left when clearing fields of from 10 to several hundred acres, and, although these fields had been cultivated, in some cases for a quarter of a century, and were often under bare fallow for from six to nine months, the Nuytsia still flourished and had not suffered from the destruction of every other plant. It therefore appears probable that the tree, after once becoming well established, was able to support itself entirely without aid.

Ebony.

In the *West Australian* of the 11th November, 1920, appears the following paragraph :—

> Ebony in the North-West.—During a visit to the North-West, from whence he returned recently, the Conservator of Forests (Mr. Lane-Poole) was interested to find ebony growing as far south as Pender Bay. The trees that he saw were not, he stated yesterday, very large, but they were known to grow as far north as Parry Harbour, and were found down the coast as far as Pender Bay. He could not say what quantity of ebony was to be found in the area between those points. He had ordered a ton to be sent down to Perth in order to ascertain whether there was any market for it.

The existence of Ebony in the North-West has been known for a long time, but no attempt has been made hitherto to determine the quantity or ascertain the quality of the local product. If the result of Mr. Pane-Poole's visit should go to show that this valuable timber exists in sufficient quantity to form the basis of a trade, a valuable addition will have been made to our knowledge of our own resources and a new industry will be brought into existence. Something like a score of woods are classed under the general term "ebony," and the widely separated countries which are the homes of this indicate that the wood is not confined to any particular region. Among the countries producing it are America, West Indies, West and Central Africa, and the East Indies.

Blackboy and its Uses.

(*Xanthorrhoea Preissii.*)

The Western Australian blackboy belongs to the same genus as the grass-tree of the Eastern portions of Australia. It is a familiar feature in the forest areas of Western Australia, and it is to be found in more or less abundance throughout the agricultural areas. The stems of the common Western Australian species are ordinarily from seven to eight feet in height, but often run up to 15 feet in height, and are very often branched. It may interest many to know that the blackboy belongs to the lily family, a botanical paradox more readily appreciated by the scientist than by the layman. It is constructed of a centre core and a very fibrous, somewhat spongy material sometimes hard enough to be termed wood, which contains a large amount of easily fermentable, sugary substance, surrounded by a thick coating of "husk," formed of the persistent bases of the old leaves lying very closely packed together, and more or less cemented by resin into a hard, coherent mass. When fire spreads through an area in which blackboy is found, it readily attacks this hard outside layer, burning and scorching it, and this accounts for the fact that the barrel of the tree is always black, with all the appearance of having suffered from recent fire. When the "husk" is broken up and beaten the brittle resin is easily reduced to a fine powder, which may be with little difficulty separated from the fibrous skeleton on which it is built up. When heated this powder forms into lumps, and becomes a substance known as "blackboy gum." In areas covered by blackboy this gum is found in lumps in the ground, the gum having probably been separated from the tree by fire and coagulated where it reached the surface of the ground. As the blackboy covers very large tracts in Western Australia, its trunk can be obtained in enormous quantities, and the gum or resin might well form the basis of a large industry. From experiments made by competent analysts, something of the potentialities contained in the blackboy have been ascertained. Among the products obtained have been glucose, treacle, scents, alcohol, and certain tar products, and from these latter again two dyes have been obtained. Picric acid, so much used in explosives, is also yielded by the tree, the gum, on treatment, giving up to 50 per cent. of its weight in the form of picric acid. The Munitions Department in England during the war made experiments with blackboy gum as a producer of picric acid, and was highly satisfied with the result. There would seem to be a great future for blackboy by-products. The subject, although well investigated by competent authorities, has not yet been exhausted. In the early days of Western Australia the settlers obtained a form of alcohol from blackboy which they used as a stimulant.

The Grass Tree (*Xanthorrhoea*) grows freely on Kangaroo Island in South Australia, and from it large quantities of gum were collected prior to the war and exported, principally to Germany, where it was used in the manufacture of varnishes and the like. It was re-exported to the United States, where it was used as a lacquer for meat tins.

Blackboy.

Western Australia is in a position to supply annually thousands of tons of clean blackboy gum at a price which should meet the views of manufacturing chemists whose business includes the many valuable products that can be obtained from the gum. Particularly in the matter of dye stuffs the capabilities of the resin should form the subject of a thorough investigation.

A number of investigators have turned their attention to blackboy, pursuing inquiries into its chemical constituents and their commercial value and utility.

The outside sheathing of blackboy is rich in many directions, yielding amongst other matters drying oils and turpentine substitutes suitable for the manfuacture of paints and varnishes, and also for other purposes.

The yields vary according to whether the material is treated dry or not. The following are given by one experimenter as the extreme limits of yield per ton of material used :—

35-45 gallons of water.

25-30 gallons of liquor containing 12-15 per cent. of acetic acid.

4-5 per cent. of methl. alcohol and 2-3 per cent. of light spirit.

25 gallons of crude oil, containing 10 per cent. light oil, 10 per cent. medium oil, 15 per cent. phenols and acids, 60 per cent. pitch, 5 per cent. loss (approx.).

8 cwt. of coke residue of high calorific value and gas (5,000 cub. ft.).

A coke residue of very good quality remains. This can be made into briquettes with any suitable matrix. It has been stated that the gross value of the products derivable from the low-temperature retorting of blackboy is greater than that from any other naturally-occurring organic material in Australia.

The most recent project in connection with blackboy is the manufacture of matches from the crown of leaves springing from the top of every tree. A resident of the Avon Valley district has been for some time experimenting with the leaves, and he has succeeded in producing matches resembling the ordinary wooden match in appearance and equally serviceable with those whose splints are really of wood. The leaves of the blackboy for match making are dried and cut into proper lengths, and then they are ready for the manufacturing process, the old leaves being equally as serviceable for this purpose as the new ones. The old leaves at the end of a season wither into a brownish colour, and matches made from them have that colour ; but when the green leaves are dried artificially they come out of a colour almost identical with that of the wooden match. An essential in wooden match-making is that there shall be no after-glow when the flame goes out. In their natural condition the resin substance in the leaves imparts an after-glow to the splint, but the experimenter referred to has succeeded in impregnating the blackboy leaf splints in a manner which secures that there shall be no after-glow.

It would seem, therefore, that in blackboy leaves there lie possibilities in the way of match-making. The material is certainly in the State and in abundance, but whether local conditions will permit of matches being produced at a cost which will enable them to compete with the imported article is a question which has yet to be answered.

Regarding the blackboy, Mr. D. A. Herbert, M.Sc., Government Botanist of Western Australia, supplies the following very interesting note :—

> The vegetation of Australia is remarkable for its multitude of curious plants, and amongst the most conspicuous are the Xanthorrhœas, known in the West as "Blackboys" and in the East more generally as "Grasstrees." In this State the term Grasstree is generally limited to Kingia australis, a tall tree very similar to the Blackboy in appearance, but differing in its drumstick form of inflorescence, which immediately distinguishes it from Xanthorrhœa. The Xanthorrhœa bears a long cylindrical spike of white flowers, giving rise after fertilisation to a black spike of seed capsules.
>
> The greater number of species are coastal, though one is known from Central Australia. Until recently fourteen species were known, twelve being Eastern and only two Western. Further search, however, has resulted in the discovery of three new species in this State, thus raising our total to five. Only one of these new forms is tall like the common blackboy (X. Preissii) and this has been named X. reflexa, the Reflexed Blackboy. It is a species attaining a height of about 20 feet in good specimens, and is to be seen at its best in the Avon district, though odd plants are to be found as close to Perth as Greenmount. Its trunk is generally unbranched (the common blackboy often branches very prolifically) and its leaf bases, the portion sold in the towns for kindling fires, are reflexed and covered with a darker gum than are those of the common form of the hills.
>
> The other Western species are not arborescent. X. gracilis, a form with a tuft of grasslike leaves and a graceful slender stalk, has long been known and is common round Perth. X. brevistyla, another trunkless species, was obtained from Narrogin last November (1920) where it grew in laterite country on hills amongst the Wandoo. Out in the eastern wheat belt in the arid sand plains the other new species named X. nana was obtained in October. This is a dwarf plant and not very common, the only local name for it being Bulrush. This is, however, an unsatisfactory name, as it bears no relation to the Bulrush either in its identity or its habits.
>
> The only species of commercial value are X. Preissii and X. reflexa, the two tall species. X nana has a certain amount of gum in its short subterranean trunk but not enough to make it of other than academic interest. Both these have a large amount of gum impregnating their leaf bases, and this has been exploited

for various purposes, such as the preparation of varnish by dissolving in alcohol, or the obtaining of distillation products such as pyroligneous acid (used for insecticides and weed killers). Before the war large amounts of Xanthorrhœa resin were exported to Germany, and the fact that picric acid could be prepared from it by the action of nitric acid gave rise to the rumour that it was being used for the manufacture of explosives. As it can be produced much more cheaply from phenol this was unlikely. Alcohol has been obtained from the inner fibrous portion of the trunk, which contains a fair amount of sugar. Numerous other products have been obtained, many of them of commercial value, some of academic interest only, but unfortunately, as Ewan Mackinnon has said, "Speaking generally, for whatever purpose it is desired to use the gum, there is already in use a substance which is cheaper and, in very many cases, better."

A further disadvantage possessed by the Blackboy is the fact that the collection of the gum-impregnated leaf bases involves the death of the plant. Its slow growth means that regeneration of cut-out areas is impracticable, though at present its wide and plentiful distribution renders it unnecessary to worry about this for present needs. The average blackboy is generally considerably older than the other trees growing round it in the forest, and several years' observation will often detect no difference in stature. It is on this account that the blackboy must be regarded as something in the nature of a mine,—to be exploited until it is exhausted. It cannot be treated like an ordinary forest crop."

Zamia Palm.

A feature of the Western Australian bush which attracted the attention of the early settlers was the Zamia Palm, botanically known as *Macrozamia Fraseri.* It is found scattered over the whole of the more temperate parts of the State, and from the time of the first settlements its " wool " has been prized as a cheap, clean and effective substance for stuffing pillows, cushions, and for similar purposes. Of recent years, more particular attention has been paid to the Zamia with the object of ascertaining whether use can be made of any other part besides the wool. The Zamia is not peculiar to Western Australia ; it is found also in some of the Eastern States. Its growth in certain parts in the East is more abundant than in the West. Here, according to one authority, it frequently attains a weight of over a ton. Under chemical investigation, starch has been found to be one of the constituents of the tree, as much as 40 per cent. of starch having been obtained from some of the larger specimens, the fibrous material representing about 20 per cent. It has been affirmed that in the Eastern States cattle browsing on the succulent new fronds which issue from the centre of the tree are liable to contract certain ailments, but in Western Australia many settlers dispute the accuracy of this conclusion, and they also traverse the statement that " ricketts " in cattle follow the eating of the central part of the plant; but there is some reason to believe that certain easily removed portions of the plant may be poisonous and may contain a substance which affects the kidneys and spinal column of certain animals.

In the early months of 1920 the Institute of Science and Industry, in the course of investigations into possible sources of power-alcohol, gave attention to the possibilities of Zamia in that direction. The following is a summary of the experience gained during the Institute's inquiry :—

> One species of this plant—Macrozamia spiralis—grows in New South Wales, and another—Macrozamia Fraseri—in Western Australia. The plant contains starch substances which can be converted into sugars by treatment with acid, and these sugars can then be fermented to produce alcohol. An investigation by Dr. Harker, of Sydney, into the New South Wales species has shown that the starch occurs in both the outer core and the inner core, and at times the outer core, which has up to the present been neglected, contains more starch than the inner. The quantity of alcohol contained from the palms varies very considerably, especially with the district in which the plant grows. From good plants about 12 to 13 gallons of alcohol per ton of the bulb is the average. The outer core is very fibrous and difficult to treat, and, unless better treatment can be devised, it is probable that only the inner core would prove profitable.
>
> The rate of growth of the Zamia is very small, so much so that it would not be profitable to grow the palms as a crop. The present growth is all that can be used. This has the disadvantage that the source of supply constantly becomes further away from the factory and the cost of collection of the raw material increases in consequence.

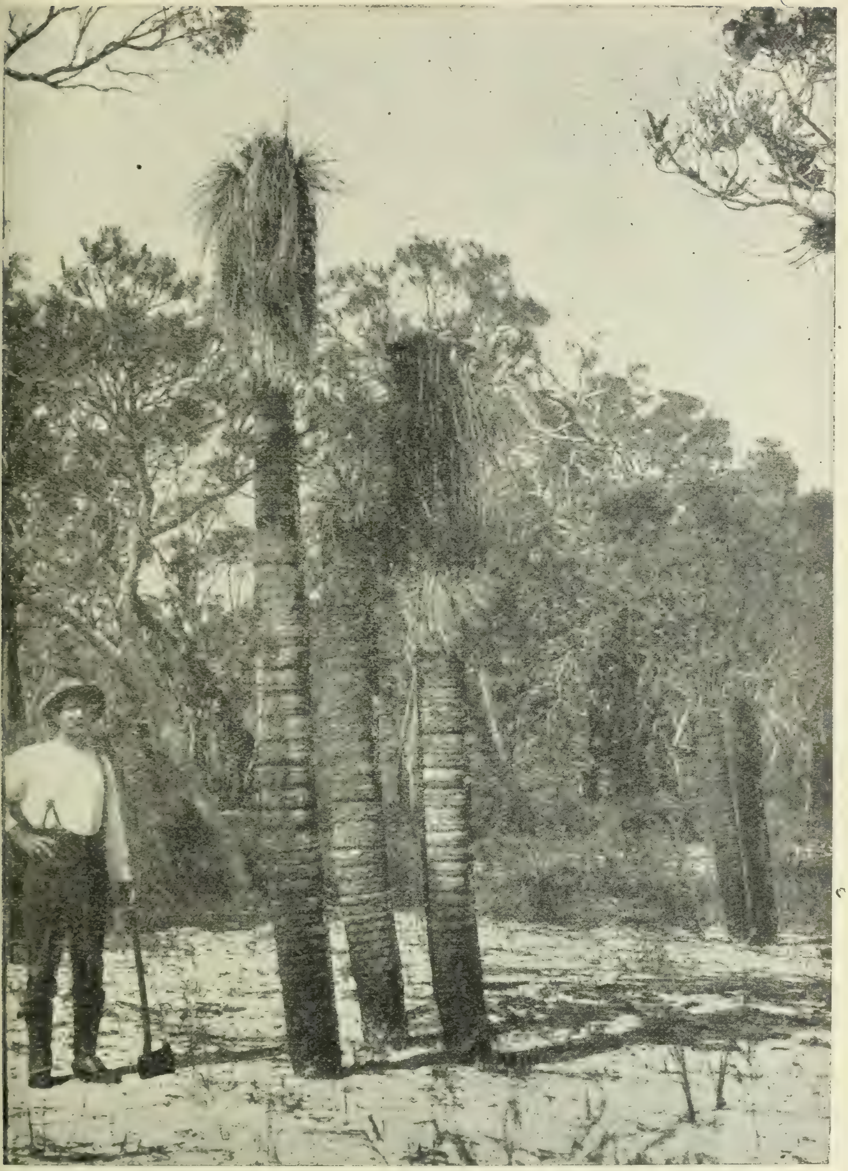
Whether or not this plant, which occurs in such huge quantities over large areas of this State, can be made a source of power alcohol, depends mainly on the cost of collection at a central spot. Practically no published work is available as to the alcohol yield from the Macrozamia Fraseri of Western Australia; nor are there any statistics as to the amount that could be collected per acre, or the cost of collection. These are matters that need to be settled, and the Council of Science and Industry have recently revised the question through the office for Forest Products Investigations. There is, however, no advantage in spending time and money on scientific investigations until the information above noted is obtained. It is sufficiently well established that a source of alcohol exists in the Zamia. The cost of producing it depends mostly upon the cost of collection. The institute is, therefore, making inquiries from the Forest Service as to how the information desired can best be obtained.

Zamia Palm.
At Palm Hill on the Warren River.
(Photograph by Mr. A. Knapp.)

Grass Tree and Grass Tree Fibre.

(*Kingia australis*).

The kingia, which takes its name from one of the State's pioneer explorers, and botanically belongs to the lily family, is peculiar to Western Australia. In appearance it has a close resemblance to blackboy, but the properties of the two trees and their commercial possibilities differ widely. The kingia does not grow in close forests, and it is found scattered over a considerable portion of the South-West, more particularly between the Darling Ranges and the sea and through the karri country to Albany. It is to be met with in abundance on the poorer classes of soil, and it may be said that the leaner the quality of the ground, the better does the grass tree seem to flourish. It attains a height of from six to twenty-five feet, and the bole has an average diameter of from nine to ten inches. The outer portion of the trunk is made up of layers or hardened masses of leaf processes. This part of the trunk is particularly rich in cellulose, and the future commercial usefulness of this portion of the tree will probably depend largely upon the utilisation of this cellulose. The trunk, it may be remarked, is almost always a black colour, like that of the blackboy, caused through the scorching of the outer layer of pressed leaves by bush fires. The core of the tree, which is hard and brittle, is also rich in cellulose, and is surrounded by a hard matted covering of fibrous material from an inch to three inches in thickness, according to the size of the tree. At the present time the main commercial value of the tree lies almost wholly in this fibrous ring round the core. It is already the basis of a considerable industry in Western Australia in the manufacture of brooms and brushes. Under treatment, there can be made from the fibre the coarse and heavy brooms used for street scavenging and similar purposes, as well as the finer material suitable for higher grade brushes. In the matter of street cleaning, brooms of kingia fibre have been used in Perth and Melbourne, and in both cities it has been recognised that the life of such brooms is longer than that of a broom fitted with any other fibre. The strength, toughness, and pliability of kingia fibre, after proper treatment, are remarkable, and its qualities only require to be more widely known to ensure for it a large demand. The process of separating the fibre from the rest of the trunk is a simple one. The heart or core of the kingia has also commercial possibilities. It contains sugar, but not to an extent which would make the extraction a commercial proposition worthy of consideration, and under distillation an alcohol has been obtained. It also presents possibilities in the direction of insulate for freezing works. The outer sheathing of the tree as well as the core being rich in cellulose, are adapted for the making of paper pulp, more particularly for the



Grass Tree.

oarser kinds of paper. In freezing works, cooling chambers, and ice afes, the outer sheaf of the kingia acts as an insulator of the first order, nd little preparation is necessary to fit it for that purpose. The kingia, nlike the blackboy, is non-resinous. The attention of the manufacturers f brooms and brushes might well be given to the kingia grass tree of Vestern Australia. It ought to replace much of the imported fibre, nd the extent to which it is found in Western Australia is a guarantee hat large and regular supplies may be had.

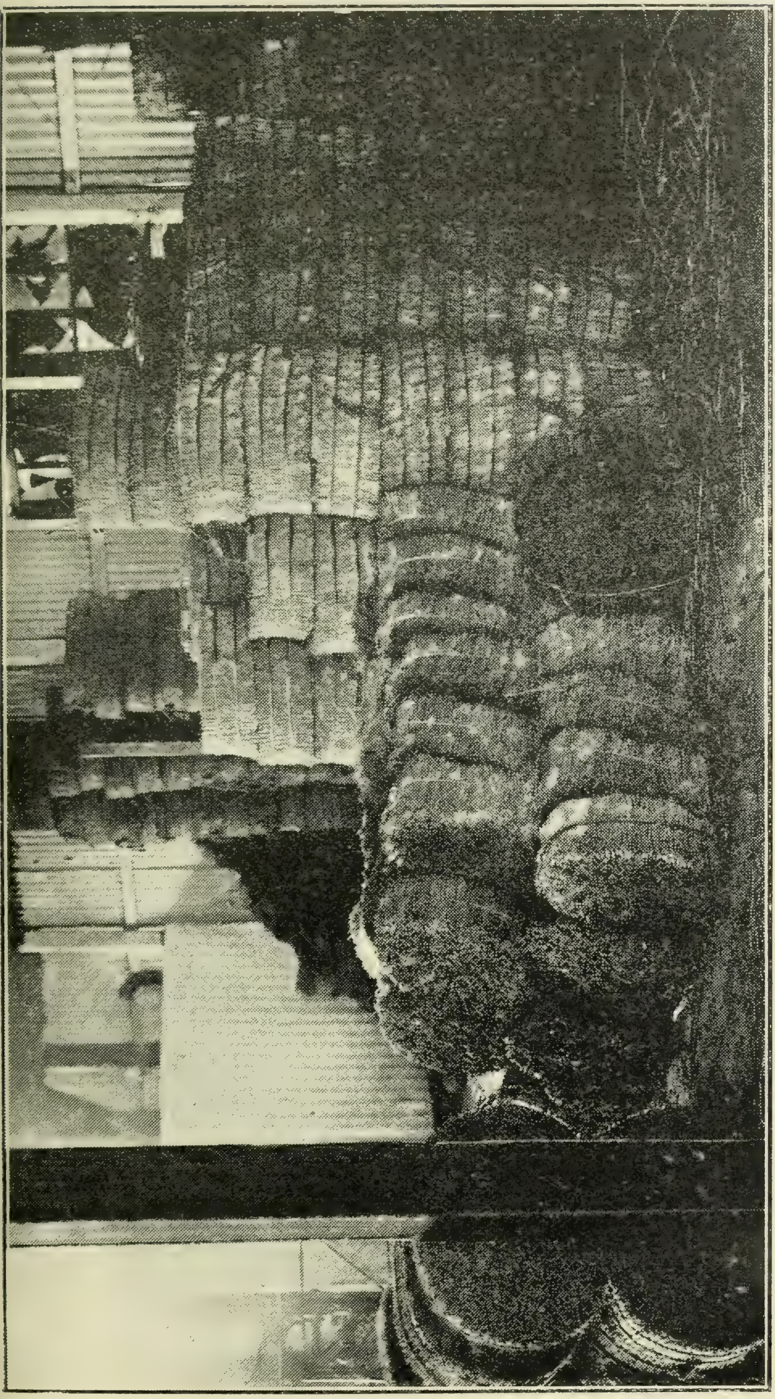
GRASS TREE FIBRE INDUSTRY.

The economic utilisation of the Kingia, which grows so prolifically over huge areas of Western Australia, is a matter of considerable importance. Up to the present the only portion of the plant that has been exploited is the layer of fibrous material that lies between the outer coating of leaf bases and the inner core. Two factories are at work removing this material and dressing it for use in the manufacture of coarse brooms. It is an excellent substitute for bass, an imported fibre formerly exclusively used for street brooms. For several years kingia fibre has been tried out on a large scale, and it has shown an undoubted superiority to imported bass. The process of preparation of the fibre is comparatively simple. It can be seen at the factory in Marquis-street. The peeled trees are received and subjected to beating by a mechanical hammer. This loosens the fibrous layer from the core and enables it to be torn off. The cores are at present wasted. The fibrous mat is dried before further treatment. The fibres are covered with a strongly adhering matrix, which is very difficult to remove when wet.

The dried fibre is treated on machines which rock it back and forth and at the same time send it forward over toothed rollers. By this means the matrix is rubbed off. The cleaned fibre is then arranged in bundles and cut into lengths by a guillotine. Finally the cut fibres are squeezed into bundles in a press and are then ready for export. During the process many small pieces are formed, and these are combed by hand and used up for shorter lengths. The whole process as at present worked is very primitive. There is no modern machinery in the State for handling such a material ; the consequence is that there is a great deal of waste both of labour and material. It is necessary to overcome this if the industry is to flourish.

The core is a very promising-looking material, which is tough and has many properties which should give it a commercial value. One of its disadvantages is the small diameter of the core, which prevents the cutting of large sheets. It should be a splendid insulator. It has also been suggested as a substitute for cork insoles and as lining for suit cases. During the manufacture a large quantity of the powdery matrix is formed. This has been examined at the Forest Products Laboratory with the following analysis :—

Moisture	40·6	per cent.
Proteins	3·1	„
Fat	0·6	„
Wood Fibre	22·9	„
Starch and Sugar	30·0	„



Cleaned and treated Kingia Fibre ready for export.

It was thought it might make a good cattle food. There seems to be some doubt of its value for this purpose. At present the value of both inner and outer portions are being tested by the Forest Products Laboratory for their paper-making qualities. If a use can be found for the enormous waste material and more modern methods of treating the fibre introduced, there is the making of a large and profitable industry in *Kingia Australis.*

Tan Barks.

The forests of Western Australia are rich in timbers, leaves, and barks containing more or less tannin, the active principle in all tanning agents. Every member of the Eucalypt family holds a certain percentage of tannin, but in very few is the percentage so great that the material can be used directly for tanning purposes. In some of them the proportion is sufficiently high to justify the making of extracts from the bark, wood or leaves. In others, such a proceeding would not under present conditions be a commercial success. With the exception of Mallet Bark, which is dealt with later, the precentage of tannin derived from Western Australian Eucalypts is, as a rule, under twenty. Certain of the mangroves in the Northern rivers show a higher percentage but, so far, the barks of these mangroves have only been used locally for tanning purposes. Sufficient is known, however, to justify the statement that the forests of Western Australia hold a wealth of tanning materials, and that only investigations such as lie within the province of a Forests Products Laboratory are needed to determine the actual value of all of them and the best means of exploitation for commercial purposes. The following list gives the result of analyses for tannin of the barks of certain Western Australian trees, made from time to time by the Government Analyst and others :—

Local Name.	Tannin Content. Per cent.
Marri (Redgum) "kino"	68
Blue Leaf Mallet Bark	47
Silver Mallet Bark	45
Brown Mallet Bark	41
Swamp Mallet Bark	36
Round Leaf Moort Bark	33
Gimlet-wood Bark	26
Spotted Gum Bark	24
Blackbutt Bark	19
Moort or Territt	16
Black Mangrove Bark	46
Red Mangrove Bark	44

MARRI (REDGUM)—(*Eucalyptus calophylla*).

However valuable this tree may be for its wood, it is likely in the near future that its commercial importance will depend mainly upon its kino or gum. The Marri of Western Australia is unique of its kind, so far as its kino is concerned. The gum exudes in large quantities, and often the ground under the tree is deeply stained by falling drops of kino. This kino contains a very large percentage of tannin. The objection to its use hitherto has been its red colour. Investigations are in progress with a view to the elimination of this objectionable feature. If success should attend these investigations, the kino of the Marri of Western Australia will become one of the most valuable products of the State's forests. The tannin material is collected by scraping the trunk of the tree and so removing the kino and kino-impregnated loose bark. The operation does not damage the tree and may be repeated at intervals of a few years. Experiments are being carried out with a view to improving the yield by tapping the liquid gum in the same way as resin is tapped from the pines. These experiments have so far proved failures. Bark which has been saturated by the kino yields, of course, a correspondingly high percentage of tannin. It is this perennial yield of gum without destroying the tree that promises in the future, when means have been found of eliminating the red colour, to be the principal factor in the establishment of a steady and large industry in kino collecting. With the exception of certain fruits yielding tannin, the collection of tan bark means, in all cases except the Marri, the death of the tree.

The whole question of the extent to which the forests of Western Australia contain materials suitable as tannages still awaits investigation. The matter is one that falls within the province of a Forest Products Laboratory. Such an institution has now entered upon the preliminary stages of its work in the State, and researches are being pushed on under the direction of Mr. Harold Salt, B.Sc., Leeds, a fully qualified leather chemist, who is attached to the laboratory, with the special object of pursuing inquiries into the tannin wealth of the State's forests. The results of his labours cannot fail to be of high economic value to the community.

Mallet Bark.

The figures relating to the export of mallet bark have already been given. In the following article quoted from "Jarrah" is presented a view of the mallet bark question, which should not be lost sight of by the people of Western Australia :—

The history of the mallet bark industry in Western Australia is fairly well known. After the war there will be some mallet bark export trade, but it will be many years before the business assumes the proportion that it did a decade or less ago. The first official record of export is in 1903, when bark to the value of £859 was exported. The next year the trade jumped to £32,876, and in 1905 it reached highwater mark at £154,087, since when it has continuously dropped until in 1913 the value of the export was put at £6,127. From 1903 to 1913 inclusive the total value of mallet exported was £864,880. The cause of the drop, of course, was unwise exploitation. Regulations were made restricting the cutting of trees below a certain diameter, but these regulations were made too late, and were more honoured in the breach than in the observance.

Most of the mallet leaving Western Australia went to Germany, and some curious sidelights on the business are derived from the study of a paper read by Dr. Johannes Passler on 25th April, 1905, in Frankfort, before the general meeting of the Central Association of General Leather Industry. One has no difficulty in gathering from this lecture that Dr. Passler is a skilled leather chemist attached to the Investigations Branch of the Technological Museum in Berlin. He does not appear to have visited Western Australia himself, but he mentions frequently the results of investigations by Dr. Diels, who spent some 18 months looking round the Commonwealth. It is gathered from Dr. Passler's paper that the earliest samples of mallet bark (he calls it malletto bark) arriving in Germany were received with grave suspicion. The mallet bark exudes under certain conditions a gum heavily charged with tannin, and this gum adheres to the dry surfaces of the bark and hardens, but in course of transit a good deal of it is found in the form of dust at the bottom of the bags containing the bark. This dust was regarded with serious doubts by the German importers, who seemed to think it was an entirely foreign substance introduced by the West Australian exporter for the sinister purpose of concealing the true nature of the bark by mixing with it the tannin-charged kino of some other tree. When the German importers were convinced that everything was right and in order they took to the bark heartily. Dr. Passler's investigations led him to form the very highest opinion of the qualities of mallet bark. He writes :—

> "It is safe to take the average of this tannin material as about 42 per cent., with an average of 14·5 of water. The average composition of mallet bark is about as follows :—

	per cent.		per cent.
Tanning substances	42·	variation ..	35·52
Non-tanning ,, ...	7.	variation ..	5.10
Non-soluble ,, ...	36.5		
Water	14.5		
	100		

> "Thus it is seen that we have in mallet bark a tanning agent which, in regard to tanning property, equals those hitherto known as the richest in tanning substances."

Then he goes on to say that at the price paid for mallet bark it is the best and cheapest thing of the kind on the German market. He goes on to say:—

> "A great advantage in the case of mallet bark lies in the fact that the tannic substances are easily dissolved in water of ordinary temperature."

In further trials of the bark at various temperature he got the following results:—

	Temperature of Solvent Waters.				
	20c.	40c.	60c.	80c.	100c. (boiling)
Tanning substances ..	39·	40·6	42·7	42·3	43·7
Non-tanning „ ..	9·3	9·3	8·9	7·3	7·7
Insoluble „ ..	37·2	35·6	33·9	35·9	34·1
Water	14·5	14·5	14·5	14·5	14·5
	100·	100·	100·	100·	100·

> "In order to thoroughly test mallet bark with reference to practical use as a tanning agent, and in order to ascertain whether it imbues the leather with any special characteristics, several tanning trials with whole hides have been carried on at the tannery attached to the institute. The tanning process occupied in all 38 days. After tanning, the skins were well washed and prepared in the usual manner for brown calf-skins. The greasing was done with a mixture of whale oil, tallow, and Degras. The leather is throughout of normal quality, the colour light and regular; the leather shows a fine and regular grain, a smooth fleshy side, and is very tough, the cut even and close and smooth; unfavourable qualities have not been observed in the leather. The result can therefore be qualified as thoroughly satisfactory."

Later on he says:—

> "The manufacturers of tanning extracts have taken and utilised the mallet bark as soon as it appeared in the German mart to produce extracts for tanning purposes, that is regular ones, which are produced with the assistance of heat, and 'cold soluble ones,' which can be thinned (weakened) by the simple addition of cold water. We have repeatedly had occasion to test mallet bark extracts at our institute. Their density varied between 22 to 24 per cent. Be, corresponding to an admixture of from 59-55 per cent. water. The tanning matter varied from 30 to 36 per cent., which is lower in these extracts than in mallet bark of average strength. All samples of extracts either contained no insolubles or only a fraction of one per cent. of insoluble matter. The leather tanned with these extracts all showed a little darker colour than those tanned with bouillon extracted from bark.
>
> "All this points to the fact that in mallet bark we have a tanning agent which, owing to its qualities, deserves the highest consideration, and which may be expected to obtain a permanent footing in our industry. In some

branches it has already established itself for regular use, which proves that the trial stages in these branches have been passed and have produced satisfactory results. Now the question arises whether the demand which is bound to increase can be met permanently and in satisfactory qualities, even if the restrictions imposed by the W.A. Government are observed strictly, after the first reckless exploitation of this bark, and even if provision is made for afforestation of denuded districts."

It is interesting to note that the German investigator seems to have anticipated what has happened in Western Australia. The tree was recklessly cut out, and the German saw that his country could not depend upon a steady future supply of the bark. Nor does he seem to have thought that the Government of Western Australia was to be relied upon to take the necessary measures for preserving mallet and for putting the industry there upon a permanent footing. So he goes on to discuss the question of acclimatising mallet in German colonies. He accordingly passes the whole of Germany's foreign possessions under review. Hereroland (German South-West Africa) he thinks an eminently suitable place for the cultivation of the tree, and certain portions of Togoland he thinks would do remarkably well, and he points to the success which has attended the acclimatisation of other eucalypts in South Africa as evidence that the Australian eucalypt is not averse to translation to foreign soil. German New Guinea and Samoa and the other former German possessions in the Pacific he considers to be quite unsuitable places for cultivating mallet, and he concludes a highly informative paper by urging upon the German Colonial Office the advisability of taking immediate steps for procuring mallet seeds.

Dr. Passler's lecture is of interest as showing the thoroughness with which Australia has been searched by the Germans for materials such as they wanted. But, so far as growing mallet in German colonies is concerned, there is available no information. It is possible, of course, that the German Colonial Office acted on the suggestion of the lecturer and that mallet is now growing sturdily in several of what were formerly German possessions in Africa. The events of recent weeks, however, seem to indicate that even if mallet has been grown in Hereroland and elsewhere the German is not likely to be the one who will profit exclusively from the fact.

It is not comforting to the national self-respect to know that the foreigner discovered the value of one of the State's forests products, and profited by it at the expense of the people of the State.

Wattle Growing.

The wattle is Australia's national floral emblem. Its rich golden flower has inspired poets, and it is always referred to with admiring pride. The other side of the shield exhibits no idealism whatever, and presents only a scene of systematic destruction. The bark of the wattle contains a powerful tanning agent, and has therefore a commercial value. The consequence has been that everywhere in Australia the wattle has been ruthlessly sacrificed for the sake of its bark. At one time the export trade in wattle bark was very large. To-day the quantity sent abroad is negligible. Australia, indeed, is now unable to supply her own wants for tanning materials, and imports largely, principally from South Africa. The irony concealed in the last-mentioned fact is that South Africa imported the seed from Australia, started growing, and kept on growing wattle while Australia was destroying it, and now Australia has practically no wattle, while South Africa's export of wattle bark and wattle bark extract runs into hundred of thousands per annum, and is yearly increasing.

The tan-bark position in Australia became so serious that the Interstate Commission of Trade, after examining all the evidence, recommended that a bounty of £1 per ton should be paid on all wattle bark grown and used in Australia. In the Eastern States the cultivation of wattle is now being seriously taken up, but so far the subject has received no attention in Western Australia. There are few landholders in the parts of the State where soil and climatic conditions are favourable, who have not some land that might well be spared for wattle culture. The following hints on the cultivation of the varieties of wattle whose barks hold the largest percentage of tannin may be of use. The golden wattle (*Acacia pycnantha*) is the best for all but the wettest parts of the South-West, in these the black wattle (*Acacia decurrens* variety *molissima*) will be most suitable. The ground should be prepared by ploughing and harrowing well. In heavy ground it will be necessary to cross-plough and re-harrow. Acacia seed takes a considerable time to germinate. It can, however, be made to germinate very rapidly by soaking. Place the seed in a bucket and pour scadling water on it, and leave it for 24 hours. It will then have swollen and become soft. Spread it out on a large tarpaulin for a few hours to dry off, and it is then ready to sow. The season for sowing depends largely on the rainfall. From one to three lbs. to the acre, according as the seed is drilled in or sown broadcast, is sufficient. In the heavy rainfall districts September is the best month, while in the 18 to 25 inches districts June to July will probably answer best. The most convenient method of owing seed is by drilling in. The drills should be six feet apart, and he seeds dropped about four feet apart in the drill. Broadcast sowing s frequently resorted to, and while using up more seed and making hinning operations more difficult, is a good alternative method. A igh stemmed tree, free of branches for the first half of its length, is vhat should be aimed at. Hence the comparatively close sowing—our feet apart in the rows. At three to four years every alternate ree should be removed. In South Africa the bark of the young trees hat have been removed is sold. In seven years the crop should be good nough to strip. In wattle growing it is most essential to lay out a vorking plan, and all operations should be conducted in accordance with hat plan. Select an area of ground, divide it off into seven equal parts, nd prepare and sow one part only each year. At the eighth year the rea first sown should be stripped, and the regular rotation of sowing an rea and reaping an area begun. Cultivators of wattle must take neasures to protect their plantations from fire. A wide fire-break ound the plantation is effectual, if kept quite clean. In between the even-yearly blocks a half-chain break will give an extra insurance, nd enable the easy carting of the crop and working of the blocks. The ost of putting in a crop of wattle must, of course, depend on the cirustances. In Victoria and South Australia the cost of stripping ranges rom £2 to £2 15s. a ton, figures which leave handsome margins of profit, vhen you consider that Natal wattle is landed at over £10 per ton.

There is a world shortage of tanning agents, and of these wattle s among the best. It would seem, therefore, that those engaging in ts cultivation are entering into a business which offers substantial nducements in the way of returns. Further than that, those growing vattle are helping to keep in the country money now sent abroad, and, t the same time, providing a fresh avenue of employment for Australian itizens. A supply of golden wattle seed is available at the State nursery or free distribution to *bona fide* growers.

Oils, Gums, and Resins.

There are few varieties of trees that do not yield more or less essential oil on their leaves, bark, or timber being subjected to a process of distillation. In most cases, however, the results obtained are of merely academic or scientific value, as the oils produced are either too small in quantity, or are of a kind that meets no commercial nor industrial purpose. The genus eucalyptus, on the other hand, is oil-producing throughout the whole of its many varieties, and several of them produce essential oils of a quality and kind that meet many commercial and therapeutic requirements, and to an extent that enables them to form the basis of an important industry. The eucalyptus oil of commerce is known all the world over and finds a large range of usefulness. The possibilities of eucalypt oil production were pointed out by Baron von Mueller in 1853 in his annual report as Government Botanist to the colony of Victoria. It was first put upon the Australian market by Mr. J. Bosisto, to whom belongs the credit of having first pointed out many of the properties as well as suggesting some of the purposes for which it was well adapted. *Euc. amygdalina* was the species first used for the distillation of oil for commercial purposes, and it is still so used very largely, but other species whose yield of oil justifies their use are now laid under contribution. Many investigations have been made into the oil-yielding capabilities of many varieties of eucalypts, but the investigator who has devoted most attention to the subject, and is indeed the leading authority upon it in Australia, is Mr. H. G. Smith, of the Technological Museum, Sydney. Writing about the yields of oil from different varieties of eucalypts, Mr. Smith says :—

> Considered broadly the variation in the amounts of oil obtainable from the leaves of any particular species of Eucalyptus depends largely on the season and on the condition of growth of the material employed. In times of drought the secretion of oil appears to diminish, or else it is used up in the struggle for existence, but after an abundance of rain the trees soon again yield the normal amount of oil.
>
> Under ordinary conditions the larger quantity occurs in the spring and early summer, when the growth is more vigorous, falling again during the winter months, and with most of the cineol oil-producing species the product becomes correspondingly richer in that constituent as the oil decreases in amount. Not only is this the case with the oil while in the leaf, but even after extraction an increase in cineol has been observed, more particularly with oils derived from species belonging to one well-defined group. Several instances of this increase in cineol after extraction will be found recorded in this work.
>
> The yield of oil from the "suckers" or adventitious shoots is, with many species, greater than from the mature lanceolate leaves, and in some cases this

increase is considerable. The constituents characteristic of the oil of a particular species are, as a rule, also those of the product from the abnormal growth, a fact of considerable economic importance.

The following tables exhibit the yield-results obtained from certain eucalypts found in the Eastern States, and from certain others indigenous to Western Australia.

YIELD OF OIL BY VARIOUS EUCALYPTS—(EASTERN STATES).

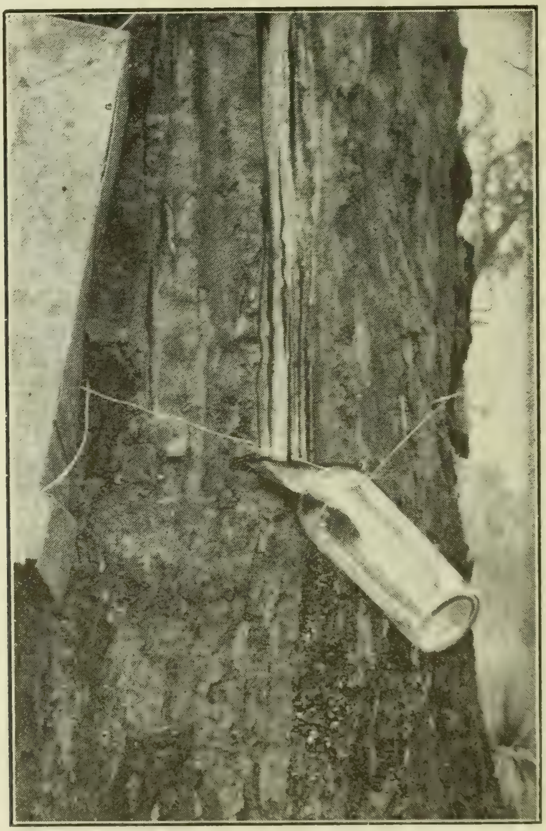
Scientific Name.	Vernacular Name.	Percentage yield.	Yield per 1,000lbs. of material.	
			lbs.	ozs.
E. Australiana	Black peppermint	3·50	35	0
E. phellandra	Narrow Leaf Peppermint ...	3·50	35	0
E. dives	Broad-leaved Peppermint ...	2·80	28	0
E. polybractea (young leaves)	Blue Mallee	2·50	25	0
E. polybractea (old leaves) ...	,, ,, ...	1·50	15	0
E. Staigeriana	Lemon-scented Ironbark ...	2·48	24	8
E. cordata	... ...	2·30	23	0
E. pulverulenta	Silver-leaved stringy bark ...	2·22	22	3
E. amygdalina	Peppermint	1·60	16	0

YIELD OF OIL BY VARIOUS EUCALYPTS (WESTERN AUSTRALIA).

Scientific Name.	Vernacular Name.	Percentage yield.	Yield per 1,000lbs. of material.	
			lbs.	ozs.
E. salmonophloia	Salmon Gum	1·44	14	6
E. salubris	Gimlet	1·39	13	14
E. longicornis	Morrell	1·20	12	0
E. cornuta	Yate	1·20	12	0
E. redunca	Wandoo	1·20	12	0
E. rudis	Flooded Gum	1·20	12	0
E. occidentalis	Mallet	0·95	9	8
E. accedens	Powder-bark	0·87	8	11
E. platypus	Moort	0·82	8	3
E. diversicolor	Karri	0·80	8	0
E. megacarpa	Blue Gum or Bullich	0·50	5	0
E. calophylla	Marri (redgum)	0·25	2	8
E. marginata	Jarrah	0·22	2	3
E. gomphocephala	Tuart	0·03	0	5

The value of eucalyptus oil depends upon the degree to which certain constituents are present, the most important of these being cineol or eucalyptol. It does not necessarily follow that a tree which yields a large percentage of oil is more valuable from the oil point of view than one which yields a lesser quantity. Some trees, indeed, yield oils for which, so far, no useful purpose has been suggested.

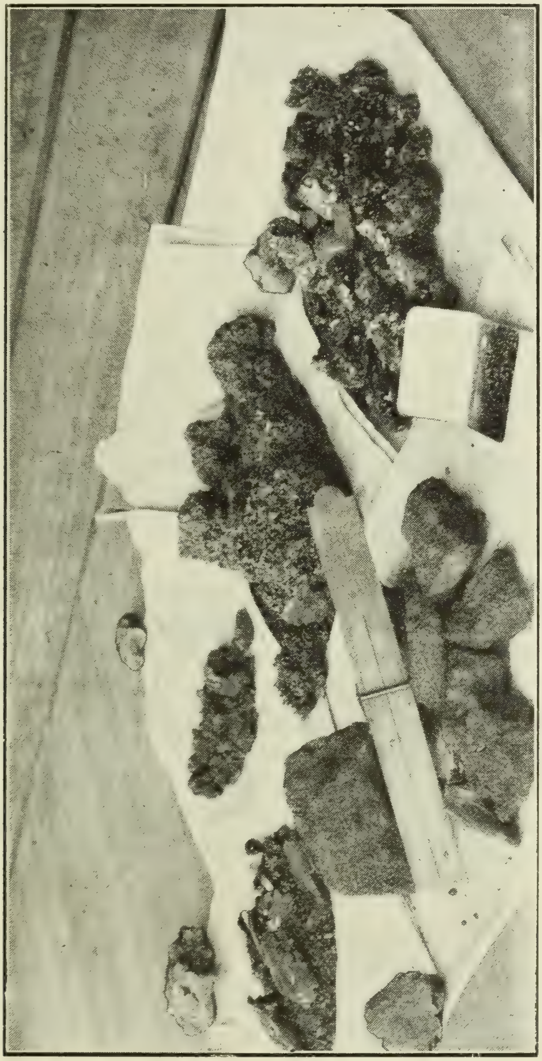
It will be gathered from what has been said that the oil possibilities of the eucalypt genus have been ascertained with gratifying completeness, but there still remain, in Western Australia at least, a considerable number of varieties whose capabilities still await investigation. In the matter of other genera, such as acacias and casuarinas, little has been accomplished in the way of discovering their oil content and its value, if any. The investigation is one that rightly falls within the province of a Forest Products Laboratory, and in the not distant future it may be hoped that the work will be undertaken. Sandalwood oil is referred to under another heading.



Tapping Marri trees for gum.

The scientific investigator who inquired into the properties of the oil distilled from the leaves of karri (*Euc. diversicolor*) says of it "the oil has apparently no commercial value, but is scientifically interesting, because the undetermined ester is evidently new, so far as eucalyptus oils are concerned, and if sufficient oil were supplied for the purpose, might be separated and determined. The oils derived from red gum or marri (*Euc. calophylla*), salmon gum (*Euc. salmonophloia*), wandoo

(*E. redunca*), brown mallet (*E. occidentalis var. astringens*), the gimlet (*E. salubris*), jarrah (*E. marginata*), tuart (*E. gomphocephala*), and other native eucalypts have also been investigated, but in no case has the oil been found to be of sufficient commercial importance to justify its production industrially.



Marri Kino lumps.

The Western Australian forest lands contain a number of gums and resins for which a commercial demand exists. The field, particularly in the North, has not as yet been fully explored. Almost since the foundation of the colony " manna " gum—the product of certain wattles, more especially *Acacia cyanophylla* and *Acacia cyclopis*—has been an article of export. Wattle gum occurs in large globular pieces, occasionally of a pale yellow colour but usually amber or reddish brown. It is transparent and highly adhesive, and is therefore particularly useful in the manufucture of adhesive mixtures. The exports are now almost wholly to the United Kingdom, but prior to the war Germany was a large buyer. Manna gum also finds a sphere of usefulness in the manufacture of certain kinds of confectionery and in certain of the arts.

The Christmas Tree (*Nuytsia floribunda*) also yields a gum which should be capable of a number of uses. It is pale amber in colour and is sometimes found in pieces as large as an egg. Blackboy gum is probably the most abundant of all the Western Australian gums. It has been exported in very considerable quantities and is used for varnish making, lacs, and similar purposes. It is referred to more in detail under the heading of " Blackboy " on another page.

The kino or gum of the marri tree (*Euc. calophylla*) is more richly charged with tannin than any other substance yet brought to light in the forests of Western Australia. Its usefulness as a tanning agent suffers from its colour. In laboratory experiments the objectionable colour has been eliminated, lessening the tannin content of the gum, and it may be expected the laboratory success will be followed by the evolution of a process which will enable the gum to be used industrially.

In 1846 a Perth merchant made it known that he was a purchaser of gums, and mentioned that he had in stock, awaiting shipment, a parcel of about two tons of the very finest gum " derived from an acacia." It is probable that the gum collected by the merchant was that of the wattle (*Acacia cyclopis*) or (*Ac. cyanophylla*), a member of the acacia family indigenous to Western Australia. This gum is of great value in pharmacy, and in the manufacture of high-class mucilage. It is admirably adapted for many classes of confectionery work, but, owing to its high price, does not find much use in this direction.

Paper-making.

PAPER FROM WESTERN AUSTRALIAN MATERIALS.

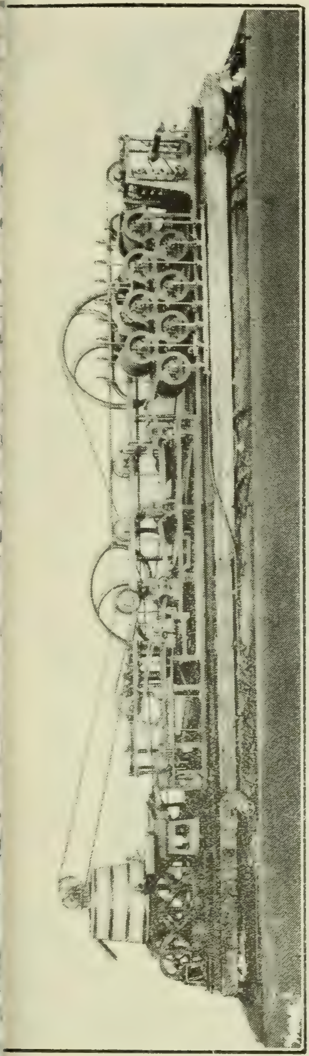
Before the war the problem of an adequate supply of paper had ecome sufficiently serious to engage the attention both of the manuacturers and users. During the war period prices soared to an alarming eight, and since peace was proclaimed prices only in certain departents have shown a tendency to recede, and any reductions that have ccurred have been comparatively small. The position is complicated, nd its incidence intensified by the fact that the sources upon which he world has for so long been dependent for its supplies of paper pulp re drying up. Canada and Scandinavia have for a great number of ears provided the bulk of the world's supply of pulp, but in both regions he forests have become seriously depleted and the authorities in each ave adopted measures for the protection from reckless exploitation f what remains of the forests.

The situation in the United States of America, where the annual onsumption of paper is enormous, has aroused a great deal of anxiety. n 1920, a committee of the United States Senate was appointed to nvestigate the paper position. During the proceedings the conviction as expressed that, if the consumption of paper were permitted to roceed at the former rate, there would be no paper pulp-producing orests left in 25 years. The abnormal size to which the American unday newspaper has grown—some of them containing more than 00 pages—was condemned by witnesses before the Committee, and it as urged that in the public interest severe condensation should be dopted. It has been stated over and over again that to produce a ingle issue of some American Sunday newspapers 21 acres of forest ust be used up, in order to produce the required paper.

The result of all this has been that every country possessing timbered reas of sufficient extent to offer a possible supply of suitable material as been searching for such material and experimenting with a view o finding which of its products, if any, are likely to form a satisfactory asis for the manufacture of paper. Australia has not been behind n this quest, and in every State investigations have been or are being ade into the paper-pulp possibilities of the forests. In Western Ausralia many materials have been experimented with, and inquiries are till being pushed on vigorously under the supervision of the officer in harge of the Forest Products Laboratory. One essential for the sucessful establishment of a pulping plant is that the material used must be in abundance. Experiments with karri and jarrah—the supply of both of which for paper-making purposes may be regarded as plentiful—have been going on in Western Australia for some time, with results which so far as karri is concerned seem to promise some hope of success. Something like 500,000 tons of these woods are burned annually in the waste fires of the sawmills in the bush, and, in addition, there is available the huge quantities of crown timber and thinnings that are left in the bush when milling logs have been removed. To turn all this timber to account is a problem that requires the earnest attention of our forest product investigators. The work of investigation in Western Australia has been carried on under many disabilities and disadvantages, but the enthusiasm and skill of those in charge of it were quite equal to all demands, and in the end gratifying success has been achieved.

In preparing the timber for experimental purposes the pieces supplied, usually limbs of trees, are cut into discs about an inch thick. These discs are then split into pieces about three inches long, one inch wide, and one-eighth inch thick. The experimenters have at their disposal two small autoclaves, one holding a couple of pounds or so of the dry chips and the other holding perhaps ten to twelve pounds. Caustic soda is also put into the autoclave with the charge of wood, and the vessel is then heated. Heat is continued for from two to five or six hours, according to the density of the timber employed. When the autoclave is opened the chips are seen to have still retained their old form, but are quite black in appearance. Taken in the hand, they can be crushed into a black, putty-like mass. Under repeated washings in cold water, this mass assumes a brown colour, the depth of the colour depending altogether upon the inherent qualities of the timber. It is now pulp, and the next process is that of beating. The pulp is placed in an oval-shaped vessel open at the top, at the middle of one side of which a very ingeniously constructed mechanical beater is fixed. The pulp having been placed in the receptacle, it is then filled with water, and the beater, operated by electric motor, is turned on. In less than a minute the contents of the beating machine have acquired a rotary motion, owing to the action of the beater on the one side, and the whole contents slowly revolve, passing round and round and through and through the beater, the operation being continued for an hour or so. The result is that the putty-like mass originally put in with the water is completely broken up.

The pulp is now ready for bleaching, and, when that operation is completed, the mass is of a lightish grey tint. The subsequent operations of spreading and rolling are of the crudest, but the result with some of the woods is that a white porous paper much like blotting paper is turned out. There is no smooth surface on this paper, for the reason hat the rolling appliances, which are operated by hand, are quite insufficient to bring the necessary pressure to bear. An up-to-date experimental paper-making plant is now on the water and should reach Fremantle any day. When that has been put in operation, it will be possible to speak with more detail of the classes of paper which Western Australian materials are capable of turning out. But so far it would seem that there are in the Western State timbers from which at least newsprint and similar papers may be made.



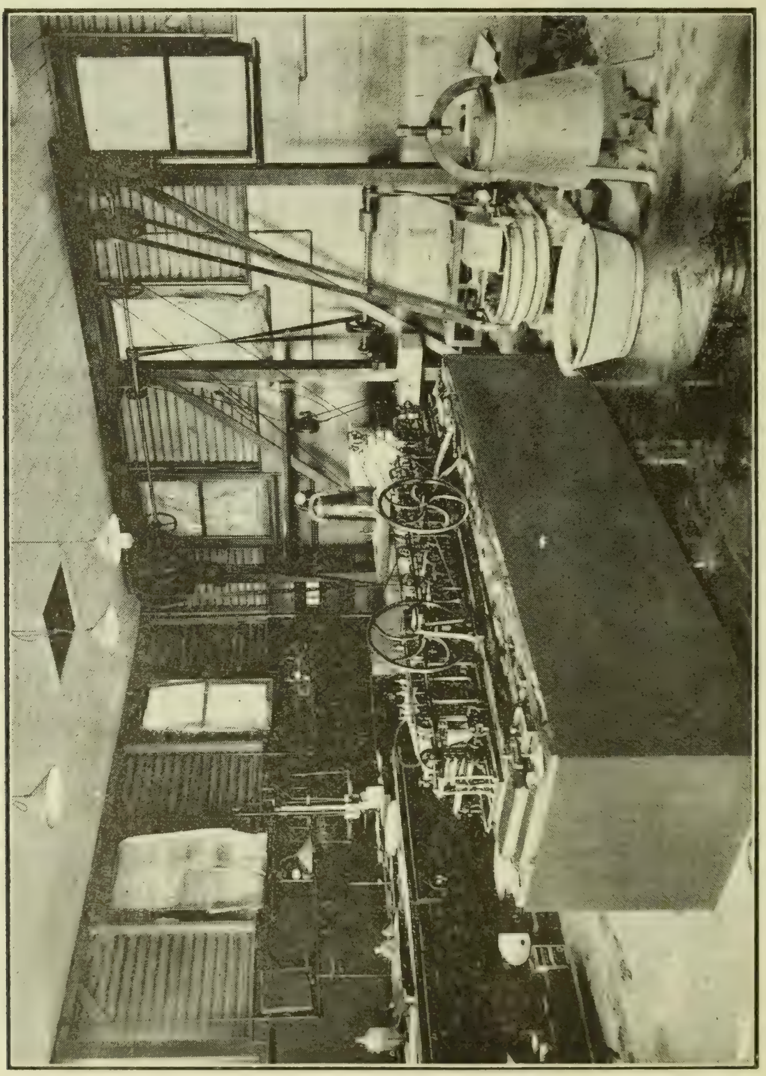
Working model of paper making machine in Forests Products Laboratory.

The crux of the whole question, of course, from a commercial point of view, turns upon cost. It is quite impossible just now to furnish any estimate as to the probable cost of turning out a ton of paper from Western Australian materials, for the reason that the experiments already conducted are insufficient to furnish the necessary data. If it should prove, however, that both karri and jarrah of any age are suitable for paper-making, others of the necessary conditions are present. Abundant water, for instance, is essential to the conduct of a paper-mill. In the karri country there are several perennial streams which might be utilised, and the same may be said of the jarrah country.

The following very informative note on the matter is from the pen of Mr. I. H. Boas, M.Sc., formerly Officer in Charge of the Forests Products Laboratory, to whose resource and initiative much of the success of the paper-making investigations is due.

The illustrations of the paper laboratory and the model paper machine shown are of particular interest to citizens of Western Australia, and the whole Commonwealth, for they indicate the first practical steps taken towards the development of the paper-making industry in Australia. The plant is only a model and the machine is the smallest of its kind in the world. The work of the laboratory, which forms one section of the Forest Products Laboratory of the Bureau of Science and Industry, is to carry on experiments into the paper-making qualities of Australian materials. Several of the State Governments are subsidising the work, and the paper-making machine was purchased from funds provided by the generosity of the principal newspaper companies in Western Australia.

The pulping qualities of several of the most likely timbers from various States have already been examined at some length and the results show that some of the hardwoods which are most abundant yield a high percentage of a good quality pulp which is readily bleached, and which felts on the machine to a good quality paper.



General view of paper-making operations. Forests Products Laboratory.

The process adopted is as follows:—The wood is reduced to chips about 2in. long and ⅛in. thick. These are fed into a digester, where they are boiled for several hours under a pressure of about 80lbs. with a solution of caustic soda. A large number of trial boils are made on a small digester to find out the best conditions for each particular sample. The time, pressure, strength of solution, and other conditions are varied, one at a time, till the maximum yield is obtained. The cooking removes the resinous matter that binds the fibres of the wood together. The pulp is washed and has the appearance of a brown mass still distinctly showing the bundles of fibres as they exist in the chips, but easily broken up.

It is then beaten out in a hollander, between fixed and revolving knives. Bleaching powder is added to remove the colour, and size and a little white china clay added. This white pulp is then mixed with a large proportion of water till it contains about 99 per cent. of water and one of pulp. This milky liquid is run from a stock tank on to the actual paper machine.

The machine is the most interesting part of the plant. On to one end pours a milky-looking liquid and from the other emerges the continuous roll of paper. After passing through various devices to feed the pulp evenly, it runs on to an endless gauze of copper wire, which moves forward and has also a sideways motion. Much of the water runs through the wires and the tiny fibres build up into a close network. As this moves on it passes over suction boxes. In these suction is maintained by two small pumps, and much more water is sucked out and the sheet of paper begins to be strong enough to bear its own weight. It then passes through rolls where it is squeezed hard. From there it leaps a gap and is taken up by a travelling band of felt and receives two more squeezings in rolls. Once more it moves forward, this time on to a series of cylinders heated by steam. The sheet of paper passes under and over these in series and is gradually dried out. Finally when dry it passes through powerful rolls which give the necessary finish to the surface.

The model machine is only 10 feet long and the paper made is 4 inches wide. This is a tremendous contrast to the modern machines, which make a sheet of paper 200 inches wide at the rate of 1,000 feet per minute. Such machine is about 100 yards long. The model, made by Marshalls, of Stoke Newington, London, is an exact replica of the large machines. It is a very useful adjunct to the paper testing laboratory and is proving of great use in the experimental work. A paper consisting of 75 per cent. of pulp from karri has been made, and it is very fascinating to watch the conversion of the dark red-brown timber into a perfectly white sheet of paper.

There is an immense amount of work to be done before all the information necessary to the establishment of the industry can be obtained. The Forest Products Laboratory is at work obtaining the fundamental facts as rapidly as possible, and the reports will be looked for with great interest by the public, and especially by that part of it which is concerned with the price of paper. There is no hope that paper will be at pre-war prices for a long period, if ever again. This makes possible the establishment of the industry in Australia. Hardwoods, once thought to be of no value for this purpose, are now being used largely. One of the largest Canadian mills is to-day using 25 per cent. of ground hardwoods in its newspaper stock. Even two years ago this was held to be impossible. Is it too much to hope that within a few years a large industry will be engaged in turning out paper in Australia containing at least 75 per cent. of Australian hardwood pulps?

Veneers and Matches.

Veneers are coming increasingly into use in manufactured goods of many kinds. The best veneers are cut from figured woods and are used for the manufacture of high grade furniture, thin sheets of veneer being glued to a backing of inferior wood, thereby using a minimum amount of valuable wood. A very strong form of veneer is made by gluing 3, 4, or 5 sheets together, and this is known as three, four or five-ply. In these the inner sheet or sheets are placed so that the grain is at right angles to outer sheets. Among the many uses to which three-ply is put are door panels, chair and couch seats, backings for wardrobes, bottoms of drawers, etc., for portions of aeroplanes, and indeed wherever lightness and strength in combination are called for. Mr. E. A. Leete, of the Imperial Forest Service, India, in his very interesting book on "Lumbering and Wood Working Industries" furnishes the following notes on the manufacture of veneers :—

There are three known ways of cutting veneers. They can be (1) Sawn; (2) Sliced; or (3) Peeled. In the first method extra thin saws are used. For slicing purposes there is mechanism for causing a massive knife to travel across the face of the block of wood. In some machines the knife runs in guides and the block remains stationary; in others, it is just the reverse.

Sawing and slicing are principally confined to heavy and ornamental hardwoods such as mahogany, etc. It is safe to say that the veneer trade would never have developed to its present proportions if no other method of cutting had been invented. The importance and huge dimensions of the industry are entirely due to the discovery that almost any kind of wood of moderate hardness can be peeled, that is, it can be opened out like a roll of carpet or bale of paper.

The writer only came across one instance of logs being peeled without preliminary treatment. Speaking of the industry in general, it may be said to be the almost universal practice to boil or to steam logs before sending them into the veneer mill. The time required is usually from 24 to 96 hours. For boiling, steam-heated vats are used with flap lids and overhead lifting apparatus. For steaming, a closed room something like a dry kiln is used. Boiling is the commoner method.

The machine used for peeling is nothing more than a lathe of a special type. The wood in the form of round billets (bolts) is mounted between the centres of the lathe, with powerful dogs at both ends. In front is a long knife, mounted on a special type of compound slide rest, which is geared to the mandrel, so that the knife steadily advances towards the bolt by a known amount at each revolution.

Provided that the motive power is strong enough and that nothing gives way, it is obvious that a short log of wood can be literally unrolled like a piece of carpet. To a novice the length is amazing. Suppose, for example, logs 3 feet in diameter are being cut into stock one-sixteenth of an inch thick for tea chests. By the time the diameter is reduced to 12 inches, the length of the roll of veneer vould not be far short of a quarter of a mile. Again, suppose that the logs are mall ones, only 15 inches in diameter, and that the sapwood (3 inches thick) is he only part that can be used. In theory, they would yield 130 running feet of eneer. In actual practice the length would, of course, not be so great in either ase. A good deal of waste is unavoidable on the outside, and deductions must e made for knots and other internal defects.

After being clipped to size the sheets of veneer are passed between a pair f rolls, to squeeze out as much as possible of the moisture, and then they are thoroughly dried.

There is no veneer making industry in Western Australia, but veneers of some of the State's woods are made in the Eastern States and are in every way satisfactory. Among the timbers that have been used for the purpose are jarrah and karri.

Matches.—What has been said under the heading of "Veneers," applies largely in the production of wooden matches. Matches are made from veneer stock. The sheets of "veneer" are cut into "splints" by special machinery, and are at once ready for heading with the requisite chemical mixture and boxing. In Sweden 24 cubic feet of good quality wood (measured in the round) is required to produce one million matches. With wood of poor quality the quantity of it required to produce the same number of matches may be anything up to double the amount named. Logs for match-veneer should not be less than 10 inches in diameter. There is very considerable waste of wood in the manufacture of matches. At least half an inch of every log put into the rotary cutter is wasted, as the veneer is rejected until it comes off in clean sheets of full width. In boxing by machinery a good deal of waste occurs, but wherever labour is cheap this source of wastage is eliminated by young people who do the boxing by hand. Under the heading of "Blackboy" will be found some particulars of a proposition to make match splints from blackboy grass.

Strength of Western Australian Timbers.

Early in the history of the timber export trade of Western Australia, questions as to the strength of the native woods as compared with the product of other countries competing in the British market came up for consideration. It may be premised that within certain limits moisture is an important factor in the strength of wood. Generally speaking, strength increases with the degree of seasoning. Freshly cut or green timber, in consequence, should be seasoned before being used for any purpose in which strength is an essential element. Defects in timber such as knots, shakes, or surface cracks, influence strength to a considerable degree. The character and position of these, however, are of importance. For instance, in cross bending stresses defects on the upper surface do not detract from the strength nearly so much as those on the lower surface.

The methods adopted in order to ascertain the strength of our woods in those earlier times were somewhat primitive. An early official report on the subject was that written in January, 1871, by Mr. James Manning, Clerk of Works, at the Convict Department, Fremantle. It was largely due to Mr. Manning's inquiries and experiments that in the end of 1871 jarrah was placed on Lloyd's list as a timber suitable for shipbuilding. A little later the strength and durability of jarrah won for it a place on the Admiralty list of timbers that might be used in the Royal dockyards. The most complete and exhaustive tests into the strengths of our native timbers were made in 1906 at the Midland Junction Railway Workshops by Mr. C. J. Julius. The investigations of Mr. Julius have reference in particular to timbers used for constructional purposes, in which it may be subjected to any of the following stresses :—

(*a.*) " Transverse " or " cross bending " stresses, as in beams which give rise to tensile, compression, and shearing stresses in the material.

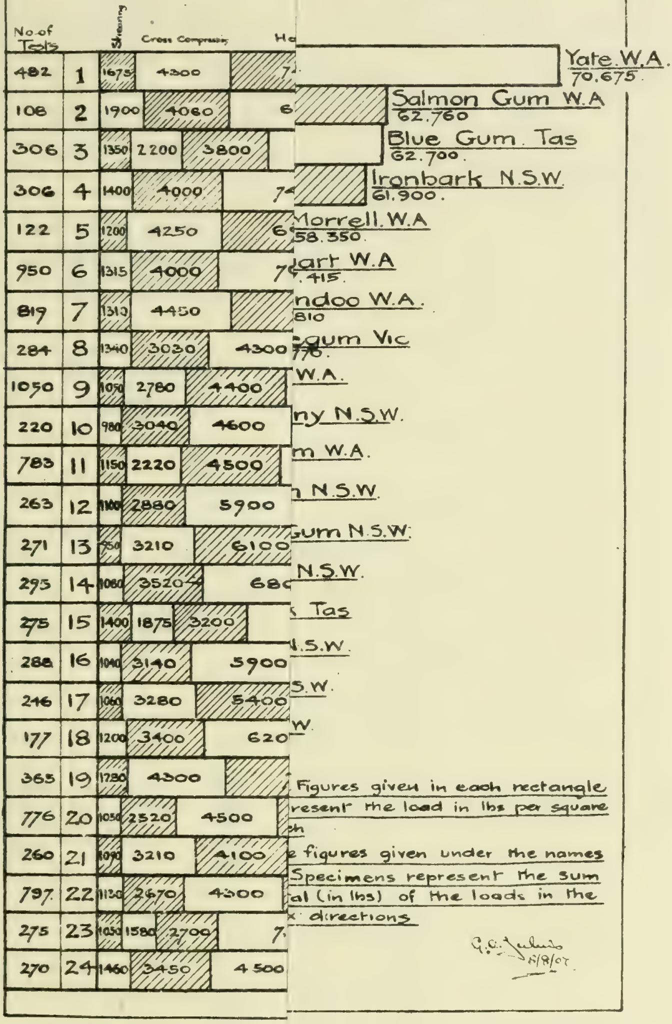
(*b.*) Direct " tensional " stresses occurring in the tension members of framed structures.

(*c.*) Direct " end " compression stresses, occurring in the compression members of " struts " of framed structures and in columns, etc.

(*d.*) " Cross " compression stresses occurring wherever a " loaded beam " is supported by a column, or upon a second beam, and also in the case of sleepers where they carry the rails.

Graphic A. Timber Tests

— 1907 —



Figures given in each rectangle resent the load in lbs per square ch

e figures given under the names Specimens represent the sum al (in lbs) of the loads in the x directions

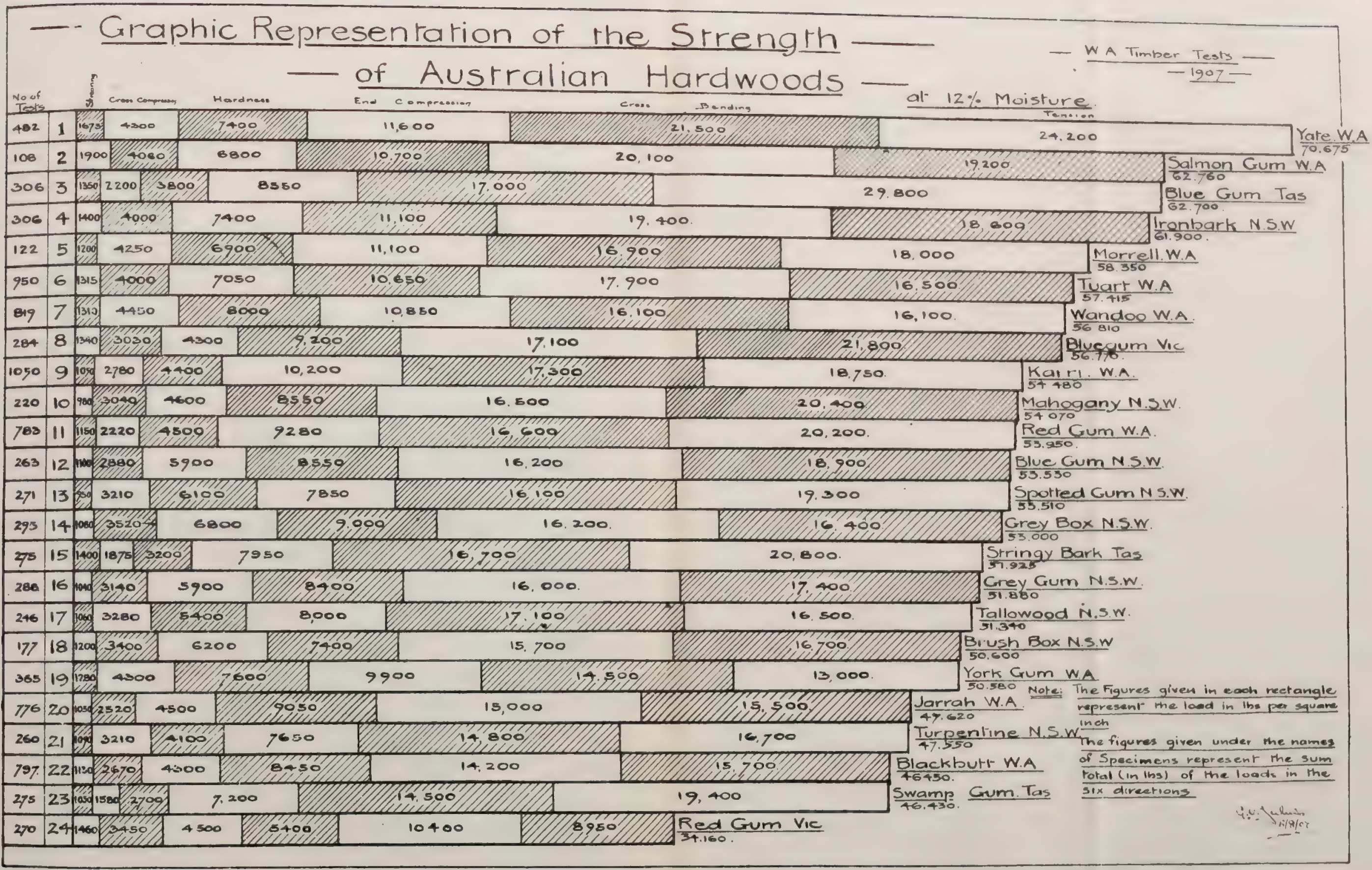
G. C. Julius 5/8/07

Gov: Print Perth.

Graphic Representation of the Strength of Australian Hardwoods

— W.A. Timber Tests —
— 1907 —

at 12% Moisture.



Note: The Figures given in each rectangle represent the load in lbs per square inch

The figures given under the names of Specimens represent the sum total (in lbs) of the loads in the six directions

G. C. Julius
11/9/07

Govt Print Perth

(*e.*) " Shearing " stresses along the fibres occurring frequently where timber is used for joists or " keys " in framed structures, and also along the " neutral " axis of beams.

(*f.*) " Combined shearing " and " compression " stresses set up in timber when subjected to blows on end, such as occur in the case of " piles " when being driven, and in " mall " heads, etc., as also to a lesser extent in the case of columns carrying a live load, such as railway bridges, piers, etc.

The following table of transverse strengths of Western Australian timbers and of some foreign woods brings into prominence the superior qualities of the native produce :—

TRANSVERSE STRENGTH OF BEAMS OF W.A. TIMBERS COMPARED WEIGHT FOR WEIGHT.

Name of Timber.	Weight in lbs. per cubic foot at 12 per cent. moisture.	Extreme fibre stress in lbs. per square inch at apparent elastic limit.	Comparison with Yate.		
			Strength.	Weight.	Strength. Weight for weight.
W.A. TIMBERS.					
			%	%	%
Yate	71	17,000	100	100	100
Red Tingle Tingle	62	14,776	86·9	87·3	99·6
Karri	58	13,550	79·7	81·7	97·6
Tuart	68	15,900	93·5	95·8	97·6
Raspberry Jam	62	14,200	83·5	87·3	95·6
Salmon Gum	66	15,000	88·2	92·9	94·9
Marri (Red Gum)	56	12,600	74·1	78·9	93·9
Sheaoak	52	11,100	65·3	73·2	89·2
Banksia	35	7,290	42·9	49·3	87
Blackbutt	54	11,000	64·7	76	85·1
Wandoo	71	13,650	80	100	80
Morrell	64	12,250	72	90·1	79·9
Jarrah	55	10,300	60·6	77·4	78·3
Coolabah (*a*)	82	14,461	85·1	115·2	73·8
York Gum	67	11,000	64·7	94·3	68·6
Native Pear	46	6,500	38·2	64·8	58·9
Karri Sheaoak* (*Casuarina decussata*)	44	5,000	29·6	62	47·7
FOREIGN TIMBERS.					
Padouk (*c*)	50	11,539	67·9	70·4	96·4
Teak (*b*)	49	10,583	62	69·6	89·2
Oregon, select	34·4	4,690	27·6	48·4	57
Oregon, merchantable ...	42·4	4,625	27·2	45·6	59·6
Oregon, 2nd quality ...	33·9	3,740	22	47·7	46·1

*The corky-barked Casuarina from the Karri country. (*a*) At 16 per cent. of moisture. (*b*) At 21 per cent. of moisture. (*c*) At 17 per cent. of moisture.

These figures too may be regarded as a cogent argument in favour of the use of home timbers in preference to the imported article. The native article is cheaper, it is stronger, and is more durable than the imported product. Further, when the home wood is used, encouragement is given to local industry and employment to Western Australian citizens.

A further demonstration illustrating the comparative strengths of seven Western Australian timbers and of oregon is to be found in the graph at the end of this book. It becomes evident from these figures and from the illustrative graph that in building construction indigenous timbers of a much smaller section than would be necessary if foreign timbers were employed may be safely used. Before the war, when huge importations of foreign timbers were made to Australia, comparatively little native wood was used in building construction. The reason for this is not difficult to find. Those interested in the sale of foreign timber were keen and active, pushing their goods upon the market with great energy. Again, it must be admitted that the native timber is harder to work than the foreign article, and this was made an excuse for employing the latter. But with the war came a shortage of foreign timbers, and the indigenous product was turned to, and it was, to the surprise of many, found able to do all that the foreign article did, and moreover do it better, inasmuch as native hardwoods are more durable than the imported softwoods.

SOME PHYSICAL PROPERTIES OF THE PRINCIPAL WEST AUSTRALIAN TIMBERS.

Name.	Weight per cubic foot green.	Weight per cubic foot at 10 per cent. moisture.*	Transverse strength per sq. inch.	Tensile strength per sq. inch.	Remarks.
Jarrah (*Euc. marginata*) ...	68	55	15,000	15,500	The principal commercial timbers of the State.
Karri (*Euc. diversicolor*) ...	72	68	17,300	18,750	
Wandoo (*Euc. redunca var elata*)	79	71	16,100	16,100	General construction work, particularly rolling stock.
Marri (Red Gum) (*Euc. calophylla*)	72	56	16,600	20,200	Yields a kino of high tanning value.
Tuart (*Euc. gomphocephala*)	78	68	17,900	16,500	Very dense and hard. Valuable in rolling stock construction.
Native Pear (*Xylomelum occidentale*)	56	46	7,660	7,000	A "figured" wood of great beauty.
Salmon Gum (*Euc. salmonophloia*)	70	66	20,100	19,200	A very strong wood with many uses found over a very large area, including the Eastern Goldfields.
Blackbutt (*Euc. patens*) ...	69	54	14,200	15,700	A strong timber, not abundant. Wood pale yellow.
Raspberry Jam (*Acacia acuminata*)	73	62	15,300	12,000	Remarkably durable in and out of ground. Strong odour as of raspberries.
Yate (*Euc. cornuta*) ...	79	71	16,700	24,200	Of exceptional strength, probably the strongest timber in the world. Many uses, including railway rolling stock.
River Banksia (*Banksia verticillata*)	59	35	10,300	8,000	Light in colour, with a beautiful grain.
Sheaoak (*Casuarina Fraseriana*)	60	52	12,000	9,000	When cut on the quarter exhibits an unusually fine and effective figure. Valuable furniture wood.
Morrell (*Euc. longicornis*) ...	73	64	16,000	18,000	Many uses, including wheelwrighting and tool handle.
York Gum (*Euc. loxophleba*)	77	67	14,500	13,000	Dense, hard, with very interlocked grain. Unequalled for naves, maul-heads, etc.

* Wood dried to a 12 per cent. moisture content is " dry " for commercial purposes.

Specific Gravity of Wood.

Inquiries by competent investigators in many countries have conclusively demonstrated that there is no very marked difference between the specific weights of the woody tissue or fibre of the chief species of timbers, but that it is about 1·56 no matter whether the tissue be obtained from soft, medium or hard woods, or be taken from the sapwood or the heart. But, so far as the actual quantity of wood-fibre per unit of volume is concerned, the various species of trees show very marked differences. Wood-fibre, it will be inferred from the figures given, must sink in water. But wood, as we know it, is buoyant in the vast majority of cases, and this buoyancy is due to the air-spaces that are throughout associated with the fibrous matter, and the lighter the wood the thinner are its cell walls. It is also probable that the wood substance itself is nearly of the same strength in all species, but this question has, so far, not been accurately determined. In investigating the physical properties of wood, specific gravity is of great value when its indications are considered in relation to strength tests conducted by modern methods. The specific gravity of any substance is its weight divided by the weight of an equal volume of water. By way of standardising the process it has been generally agreed that the water-unit used shall be a cubic foot of distilled water at a temperature of 4°C (39·2°F), the weight of such water being 62·425lbs. to the cubic foot. When it is not convenient to obtain a block of wood of precisely a cubic foot in volume, the specific gravity of the timber may be arrived at in other ways, and probably the most usual of these is by the immersion process.

The specific gravity figures usually given in tables refer to wood that is commercially dry (*i.e.*, containing 12 per cent moisture), but those for green timber are also sometimes given. The weights given in the table hereunder are for timber at 12 per cent. moisture, and are obtained by Mr. C. A. Julius, B.Sc., from a large number of samples tested by him at the Railway Workshops, Midland Junction, and the specific gravity figures have been calculated from these weight figures.

WESTERN AUSTRALIAN TIMBERS.

	Average weight at 12% moisture.	Specific gravity.
	lbs. per cub. ft.	
olibah	82	1·313
ndoo	71	1·138
te	71	1·138
art	68	1·089
rk Gum	67	1·074
lmon Gum	66	1·057
amp Oak	65	1·041
rrell	64	1·025
m	62	·994
d Tingle Tingle	62	·994
rri	58	·929
rri	56	·897
rrah	55	·882
ackbutt	54	·865
eoak	52	·833
tive Pear	46	·737
nksia	35	·560

TIMBERS GROWN OUTSIDE WESTERN AUSTRALIA.

	Average weight at 12% moisture.	Specific gravity.
	lbs. per cub. ft.	
ignum vitæ	73	1·169
onbark	71	1·138
rey or White Box	68	1·089
allowwood	63	1·009
potted Gum	60	·963
urpentine	57	·913
nglish Oak	52	·833
ickory	51	·817
merican Oak	48	·768
eak	47	·753

State Nursery.

An important branch of every Forest Department is the raisin of young trees for use by the Department itself in afforestation wor and also for the convenience of private citizens, particularly farme who desire to grow timber for shade purposes, for use on the farm, o for sale at maturity. The Western Australian Nursery is situated a Hamel, and there hundreds of thousands of trees of many varieties ar raised. In some of the farming districts of the State, the original holde of the land, with an eye only to the present and the immediate futur practically denuded their holdings of all timber, thus depriving themselve and their successors of the countless advantages following the presenc of timber on the farm. The value of what in America and Canada i called the "farmer's wood-lot" is not yet sufficiently recognised i Australia, although in some of the older settled districts the errors o earlier times are being repaired by vigorous planting of trees. Ther are few farms that do not possess more or less land unsuited for the raisin of wheat and other crops, but perfectly adapted for growing of suc timbers as may suit the soil and the rainfall of the particular district These areas, when planted with trees, form very valuable assets and when the "wood-lot" has been well established and is yielding its yearl crop of mature timber, the area of ground which was once regarded as o little or no value at all becomes one of the most profitable on the holding.

The nursery at Hamel grows trees suitable for the temperate are of every part of the State, and seedlings of these may be had by farmer and others in quantities to suit them and at prices which cover only th cost of raising them.

INSTRUCTIONS HOW TO TRANSPLANT.

Choose a calm cloudy day if possible.

From Trays.

No. 1 *method.*—Water thoroughly at least two hours before transplanting. Remove each plant and a portion of the surrounding soi with a very sharp trowel. On no account attempt to disentangle th roots. Water again after transplanting, and, to ensure success, if practicable water occasionally during the subsequent dry weather.

No. 2 *method* is similar to No. 1 with the exception that instead o using a trowel the side of the tray should be cut with a sharp knife Then cut the soil in sections, leaving a tree in the centre of each section Be sure to use a sharp knife.

Forest Products Laboratory.

There lingers in some quarters the belief that the value of forested ntry is limited to the raw timber that can be got out of it, and to capabilities as an area on which stock may be depastured at certain sons of the year. Such a conception is entirely at variance with the ts. Indeed in certain classes of forests the raw timber they produce f comparatively small moment when set against the value of certain er materials that they yield ; in other cases these products add terially to the amount derived from the forests, and in every instance estigation by skilled workers has never failed to discover many items value hitherto unsuspected. The potentialities of the Western Aus- lian forests in the direction of other products than timber are as yet t little known. It has been ascertained already that the forests of the te yield oils, gums and resins, but to what extent is so far only a tter of conjecture. We know about sandalwood oil, blackboy gum, lgum kino, grasstree fibre, and of some other articles of value in com- rce, but it is no exaggeration of language to say that the vast field s only been touched, but in no sense explored. Thorough explora- n calls for the exercise of great skill allied to high scientific attain- nts. In other words, such work belongs to the province of a Forest oducts Laboratory.

There is no subject more important in the economics of timber an research into timber waste. When a jarrah tree is felled half the tree only is brought to the mill, viz., the log ; the rest is wasted. hen the miller converts it into sawn wood he recovers only 40 per nt. of the total cubic contents. The system of measurement—quarter rth—causes an under-measurement of 21½ per cent., so that a 50 per nt. recovery is really only about 40 per cent. The remainder is burnt. very year we burn at our sawmills 500,000 tons of wood, exclusive sawdust and rotten hearts—in other words, sound wood. Setting t these figures, we have :—

Crown, branches and twigs—50 per cent. ;
Sawdust—5 per cent. ;
Rotten hearts—10 per cent. ;
Mill waste—15 per cent.
Sawn timber—20 per cent. ;
Tree in forest—100 per cent.

ighty per cent. of the tree is destroyed and lost, and it is for a forest roducts laboratory to find uses for the various parts now wasted.

THE SCOPE AND PURPOSE OF SUCH AN INSTITUTION.

The general aims of this institution are as follows :—

1. To test all commercial woods with respect to their physical mechanical, and chemical properties.
2. To study the causes of the decay of wood, and test methods for the preservation of wood.
3. To study the fundamental problems concerning the manufacture of wood-pulp, wood alcohol, acetic acid, essential oils, resins, and other products obtained from trees.
4. To find methods for the utilisation of wood waste.
5. To provide free information on the properties and utilisation of all forest products.

In order to conduct research in these directions the Forest Products Laboratory should be organised into divisions, each with its staff of technologists and quota of equipment. These divisions are as follow :—Timber Physics, Timber Tests, Pulp and Paper, Wood Preservation, Administration.

The work of administration necessarily includes the collection of information and management of the library, which will be a valuable up-to-date repository of technical information on the properties and utilisation of all forest products. This library will be, of course, of the greatest value to those engaged in the work of the laboratories, but may also be consulted by anyone interested in the characters, uses, and manufacture of all tree products.

In the United States of America there is a Forest Products Laboratory at Madison, Wisconsin, and in Canada there is a similar institution at work in connection with the McGill University at Montreal. It is no straining of language to say that these institutions have revolutionised the outlook upon the forest resources. Their activities have covered a wide range, and the practical results of many series of experiments and investigations have taken the form of the establishment of new industries in the countries named, and the perfecting of processes which in the past have beeen either ineffective or absolutely useless.

The Madison institution has a staff of over 300, and from it there flows a continuous stream of bulletins and other information relating to its work. The kiln drying of timber, to quote only one example, from crude, primitive and unsatisfactory methods, has become stabilised hrough the work of the laboratory, and the results can be now obtained vith precision and certainty. The physical properties of timber and heir relationship to preservation have been investigated, with the happiest results. The laboratory has demonstrated beyond a doubt hat no one method of timber preservation can possibly be effectual vith woods of varying densities. One process must be applied in the ase of softwoods, another is adopted for medium woods, and still another has reference to hardwoods.

The shortage of paper-making materials in America has created a roblem of great difficulty and much complexity. For at least a couple of years the laboratory in Madison has been busily engaged in investigating the paper pulp-making possibilities of large numbers of trees. Hitherto spruce and conifers have almost wholly been employed, but he demand for paper is so great and increasing that the valuable supplies of these are approaching depletion. It was necessary, therefore, that nquiries should be seriously prosecuted into the capabilities of other voods, and that is being done in a manner which shows that the best qualities of paper can be made from many other woods besides those named.

In kiln-drying of timber the Madison Institute has stabilised a kiln, and similar work is being carried on to-day in Western Australia n drying kilns designed on the Madison model.

Glues form another subject which has been investigated, and the Laboratory's publication on the question may be now regarded as a standard work. In Canada inquiries along similar lines have been pursued with much success, and the vast Canadian forests are now yielding vealth in many forms beyond that of raw timber and pulp wood.

It should be stated here that both the Madison and Montreal institutions carry on their work with a cosmopolitanism which is as rare as it is worthy of the highest commendation. Both of them willingly mpart to other peoples besides their own every detail regarding their nvestigations, and they, with every courtesy, place their vast source of information at the disposal of all inquirers.

It has now been demonstrated beyond a shadow of a doubt that uture economic conditions will demand that the yield of forests shall not be confined to timber only. The exigencies of increased production make it essential that every avenue must be explored if a community is to march in the forefront of progress.

The extent of the forests of Australia and the fact that their possibilities beyond timber are almost wholly unknown make a forest products laboratory a necessity. We know that tanbarks are to be found in the forests and that essential oils can also be extracted from many of the trees, but our knowledge so far of the hidden wealth of the woodlands is fragmentary. But such as it is, it undoubtedly suggests that competent investigation cannot fail to produce satisfactory results. For over two years the question of the establishment of a forest products laboratory has been under consideration of the Federal Government and of some of the State Governments, more particularly that of Western Australia.

The matter was brought before the Interstate Forestry Conference in Perth in 1917, and a resolution was passed urging the establishment of such an institution. Since then, at the Forest Conference at Hobart, in 1920, the resolution was reaffirmed with the addendum that the first laboratory should be in Western Australia. The Conference of Premiers in Melbourne in 1920 had the matter under consideration, and endorsed the resolution of the Forestry Conference. The first negotiations between the Federal Government and the Government of Western Australia, in which tentative arrangements were arrived at for the establishment of the laboratory at the joint cost of the Governments, were held in abeyance until the Institute of Science and Industry had received legal sanction by Parliament. An Act incorporating the Institute has now been put upon the Federal Statute Book, and, as a consequence, the negotiations between the Federal Government and that of Western Australia were resumed, with the result that an appropriation has been granted by the Federal Government, as well as by the State Government, towards the building and equipment of a laboratory in Perth.

It seems, therefore, that Australia is now entering upon a course which will enable her to extract other wealth from her forests than raw timbers. The laboratory, when building and equipment operations have been completed to the necessary point, will undertake investigations not only into the forest products of Western Australia, but also into those of the forests of other States. It is probable that the first investigation of the laboratory will be directed towards paper-making and tanning materials, both of the inquiries being under the charge of experts.

Kiln Drying of Timber.

All over the world the increasing use of timber in arts and manufactures has given rise to a wide demand for steady supplies of perfectly dry wood. There are numberless purposes to which wood is applied whose success depends entirely on the use of material in a perfectly dry condition. The process of seasoning timber may be effected in two ways—either by stacking the wood in the open or in sheds in such a way that the air may have free access to it, or by the use of kilns scientifically constructed and operated on principles which will bring about the desired result in the shortest possible time. Seasoning adds to the value and usefulness of timber in the following directions :—(1) It reduces the weight. Jarrah, for example, loses one-third of its weight in passing from a green state to a dry one ; (2) it prevents warping ; (3) it shrinks timber to a point at which working is reduced to a minimum : jarrah boards shrink 6·8 per cent. of their width in drying ; (4) it increases the strength of the wood. This reason is not as generally known as it might be. Mr. Julius, in his exhaustive tests of Western Australian timbers, found that the transverse strength of green jarrah was 10,600lbs. per square inch, while that of dried jarrah was 15,000lbs. per square inch ; (5) it renders timber less liable to fungus attacks. Rot is caused by the attacks of fungi, which require a moist medium in which to take root. Green timber, with its high moisture content, provides this favourable medium. How well dry timber resists rot is shown with karri, which, if seasoned before being used, is remarkably free from dry rot. (6) Drying makes it possible to paint and polish wood.

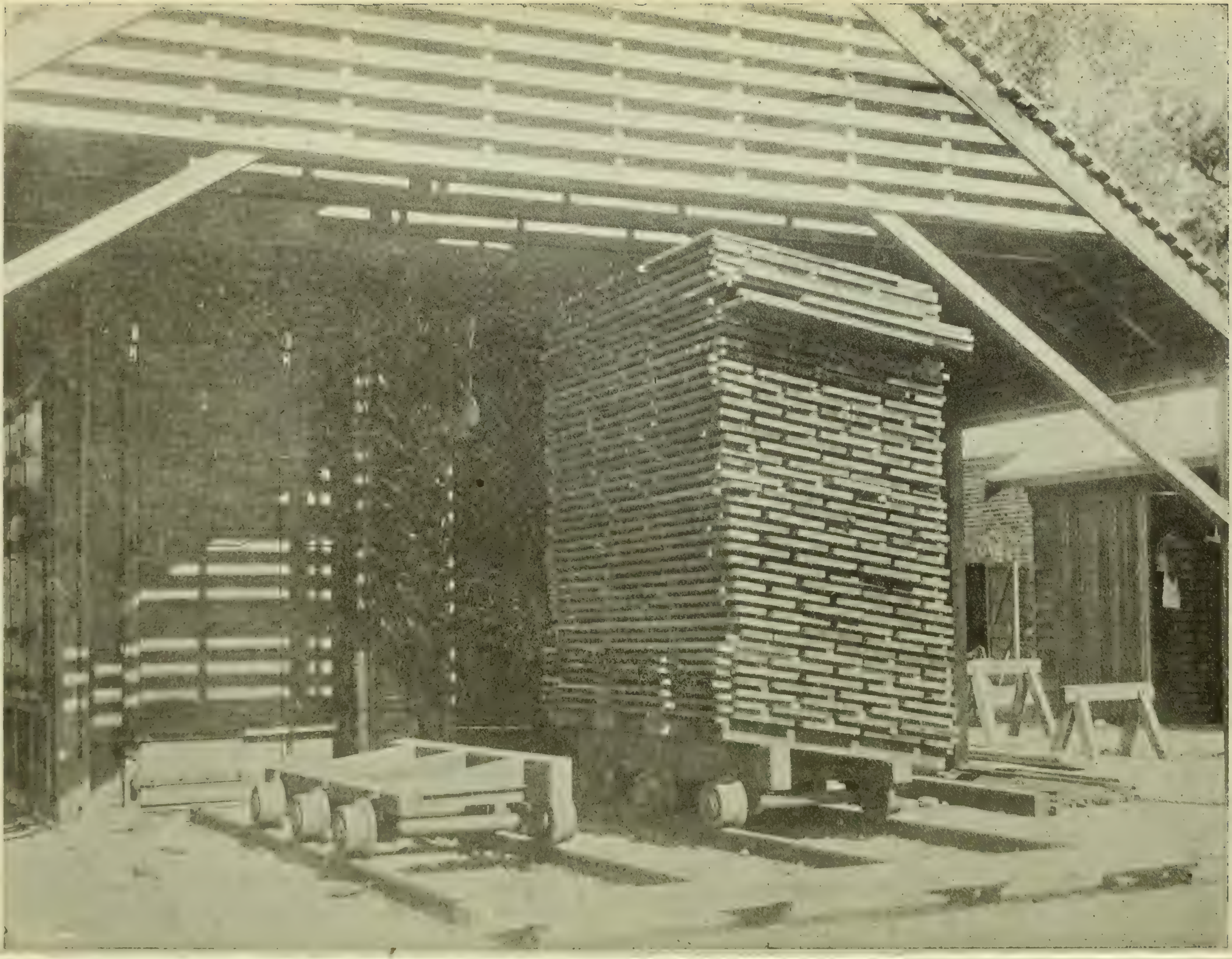
The seasoning of timber by other methods than air drying has engaged the attention of timber users for a long period. Many systems have been evolved, but most of them have for one reason or another failed to realise the expectations of their inventors. Kiln-drying has received attention to a greater degree in America than elsewhere. After careful study of the factors involved, and long and exhaustive experiments, America has produced several types of kiln which give satisfactory results. The best of these probably is that constructed by Mr. H. D. Tiemann, an officer of the Forest Products Laboratory at Madison, Wisconsin. It is long since the notion that timber could be successfully dried by dry heat was exploded. Dry heat alone invariably exaggerates the imperfections which usually attend open-air drying, and produces others equally disastrous. Dry hot air leads to warping, splitting, and checking, and "case-hardening," a condition which, owing to the difference in tension between the dry outside surfaces and the moist interior, produces serious warping and splitting. In modern

kilns—including the Tiemann—drying is effected by moist or humid air. If success is to be achieved there must be kept up during the whole process of drying a certain relationship between humidity and temperature within the kiln, and, as this relationship varies according to the stage of the process, the determination of that varying relationship is a matter that calls for the exercise of much skill and care, and, at the same time, calls for intimate knowledge on the part of those carrying out the operations, of the physical properties of the woods being dried. Hardwood, such as our jarrah and karri, cannot be successfully dried under conditions exactly similar to those which succeed with American soft and medium woods. In adopting the Tiemann kiln, so far as its basic principles were concerned, the first investigators in Western Australia found it necessary to modify some of the conditions that prevail while soft and medium woods are being treated, and it was only after study and experiment that the conditions that would bring success with hardwoods were ascertained. The first experimental kiln was erected, jointly with Messrs. Millars' Timber and Trading Company, in that firm's yard in Nash Street, Perth. The work done at this kiln was of great value, as the experiments materially assisted in determining the variations from the Tiemann kiln that were essential if hardwood was to be successfully dried.

A second kiln was erected in the grounds of the Univeristy at Crawley, and at it perfectly dried timber is turned out. The product of this kiln is eagerly sought after by furniture manufacturers and others whose business demands timber in a thoroughly dry condition. Messrs. Millars' Timber and Trading Company, at their sawmills at Yarloop, have erected a drying kiln on the principle of that at Crawley, and are turning out kiln-dried timbers on a commercial scale.

EXPERIMENTAL DRYING KILN.

The picture of the experimental drying kiln is that of the structure erected in the University grounds at Crawley, Western Australia. It has been over a year in operation and the process has already been described. The kiln is the property of the Forests Department of



Western Australia, and all the operations are carried on at the expense of the Department. Timber for experimental purposes is purchased from the State or other sawmills and, after being dried, it is eagerly sought for by furniture makers and others in search of thoroughly dry wood. The following particulars as to the time taken in drying wood at the experimental kiln may be of interest.

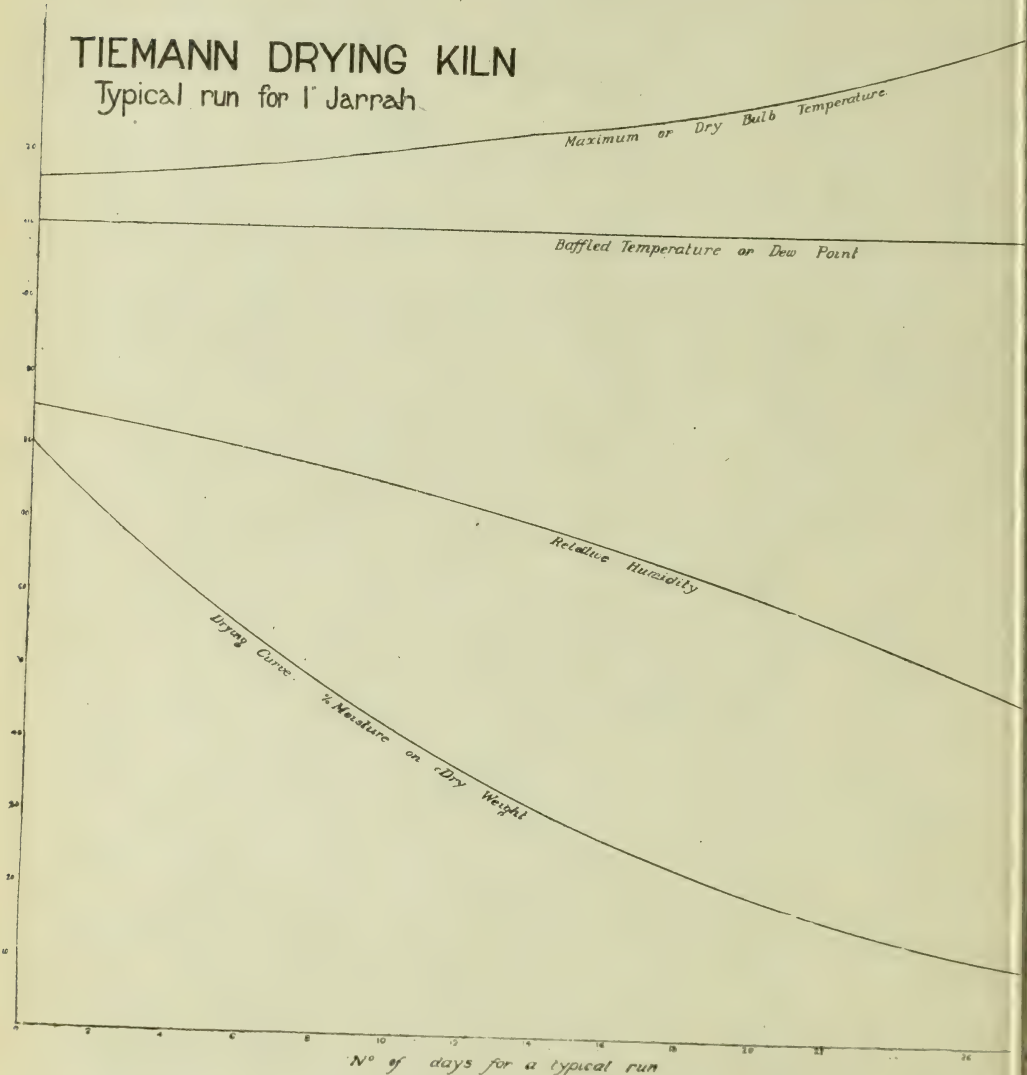
Approximate time of drying jarrah boards 1in. thick, 20 days.
Approximate time of drying jarrah boards 1½in. thick, 30 days.
Approximate time of drying jarrah boards 2in. thick, 40 days.
Approximate time of drying jarrah boards 3in. thick, 60 days.
Approximate time of drying karri boards 1in. thick, 35 days.
Approximate time of drying karri boards 1¾in. thick, 70 days.

It will be noticed that karri takes a considerably longer time to dry than does jarrah. This result is in agreement with the ascertained facts that the difference in weight between jarrah green and jarrah dry is less than that between karri green and karri dry.

MORRELL.

Its Behaviour under Kiln Drying.

According to "Julius' Tests on the Timbers of W.A.," one of the hardest and densest of our timbers is Morrell (*Euc. longicornis*). So far this timber has been practically of no commercial value, its chief use being for firing the furnaces of the big mining plants at Kalgoorlie. The properties of this timber commend it for more useful purposes; notably for wheelwright work such as spokes of wheels, etc. The Forests Department of Western Australia desired to put in hand recently some experiments in this direction, but seasoned Morrell was unobtainable. A consignment of the timber, cut from green logs, was however, forwarded from Kalgoorlie and recourse had to be made, not without some misgivings as to the ultimate result, to the experimental drying kilns of the Department, to season the timber. These misgivings as to the behaviour of such a close-grained dense timber, when subjected to this artificial drying process, were found to be without foundation, and the results exceeded the most sanguine expectations. Temperatures much lower than those used in drying jarrah or karri were used, the maximum temperature being 120 deg. F. and the relative humidity never below 40 per cent. ; nevertheless the charge, which averaged 30 per cent. of moisture (on dry weight) when first placed in the kiln, was dried down to 8 per cent. in 21 days, and proved to be just as amenable to the drying process as any of the more porous eucalypt timbers experimented with up to date. No defects, such as checking, etc., were occasioned by the kiln drying, the only variation from the normal experienced being that the timber, as shown by a pronged section, was slightly case-hardened. The prongs, turning in as they did, indicated that the outer core of the timber had dried more rapidly than the inside and become set. The



side then started to dry out more slowly, and consequently shrank more.
his is shown by the prongs turning inwards. The stresses involved
y this state of affairs can be relieved by subjecting the timber to live
team. Steam, therefore, was allowed into the kiln, until the temperature
ached 160 deg. F. Generally two hours of such treatment is sufficient
o neutralise any such stresses involved in the drying of jarrah or karri
f similar thickness, but with this timber at the end of the first day (after
hours' steaming) the stresses, as evidenced by a pronged section, were
s pronounced as ever. The kiln was, for various reasons, closed down
vernight and the steaming resumed next morning, and continued for
nother 8 hours at the same temperature, after which time a pronged
ection still showed that the stresses had not been relieved. Unfor-
unately a case-hardening test was not taken before steaming was com-
enced on this, the second day of steaming, but the prong, when cut
rom the board, had become quite normal when left to stand in a room
vernight. At the end of the second day steam was again shut off,
nd next morning a test was taken from the same board, when it was
ound that the stresses within the timber had disappeared. This result
s indeed very curious when it is remembered that these prongs were
btained respectively from adjacent strips of the same board, and that
o further steam was allowed into the kiln after the prong was obtained.

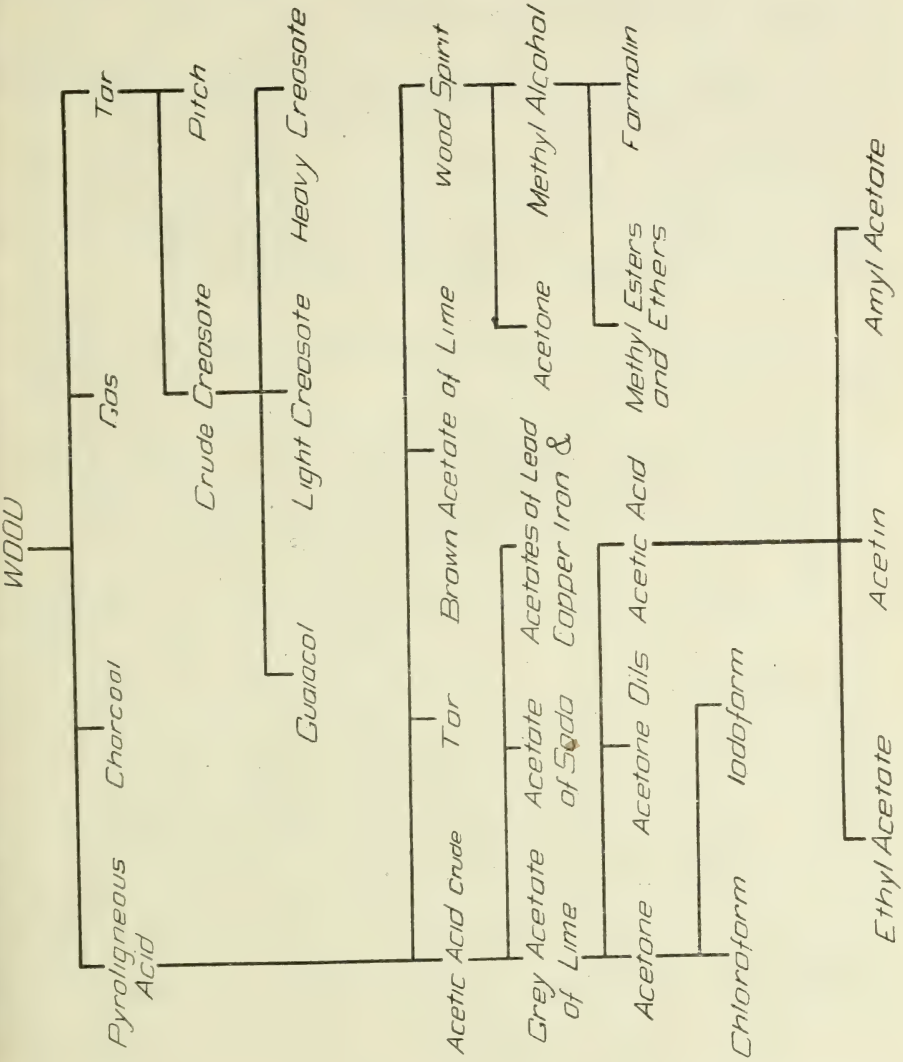
Distillation of Wood.

Of the many methods of utilising waste wood, distillation seem to offer the greatest possibilities for effectively dealing with a considerab proportion of the total waste. Most other proposals can only b applied to a relatively small proportion of the material available. Di tillation offers the possibility of a large industry and one, moreove that is a key industry, for its products are of the utmost importanc as raw material in the manufacture of various munitions of war an for general commercial purposes.

It has long been known that wood is capable of conversion int substances quite unlike their parent. It is many centuries since charco burners noticed the residuum of tar after their operations. This tar wa believed to have high medicinal values and was used accordingly. I is only of recent years, however, that scientific principles have bee applied and scientific methods adopted for the determination of th whole content of wood fibre. A systematic distillation of timber fo the purpose of recovering its by-products has now developed into a industry of enormous dimensions. The development, of course, ha been step by step. The first factories established for the purpose contented themselves with the production of such substances as crud pyroligneous acid and acetates in addition to the tar and charcoal. A the time these early plants were in operation no use had been foun for the wood spirit, but to-day four main primary products are mad namely charcoal, grey acetate of lime, wood spirit and tar. In man cases plants for the production of pure acetic acid and acetone hav been installed at the old distilleries, and other products derived fro the primary woods are now manufactured on an ever-increasing scal

According to an Indian authority, it is estimated that about thre million tons of wood are distilled every year throughout the world fo the sake of their by-products, producing approximately 150,000 ton of acetic acid and 15,000 tons of wood spirit. In the United States who forests are cut down, and the production in that country is about ha that of the total. The industry has also assumed large proportion in Canada, where half the remainder is distilled, while the remainin quarter is treated in Europe, mainly in Germany and Austria. Th greater portion of the acetate of lime is converted into acetic acid. I is used in dye-making and for the production of salts and other secondar products, such as esters, for which there is a large demand. Many o the salts are used in the dyeing industry, while the esters may be use for flavouring and perfumery purposes, or in the synthesis of more complicated chemicals.

Another most important product obtained by distillation of the ey acetate is acetone, which is largely used as a solvent, particularly the manufacture of cordite, as well as being employed in the manu-cture of chloroform and iodoform. Wood spirit is used in a partly fined form for the denaturing of alcohol and for the preparation of varnishes, and enormous quantities are consumed in this way. Many thousands of gallons are carefully purified, giving methyl alcohol, which is essential for the manufacture of many important dyes, and is the material from which formalin is made. From the tar, drugs such as creosote and guaiacol, can be separated, and even the charcoal dust is now worked up into briquettes to be used as fuel.


WOOD
Tar
Gas
Charcoal
Pyroligneous Acid
Pitch
Crude Creosote
Heavy Creosote
Light Creosote
Guaiacol
Wood Spirit
Brown Acetate of Lime
Tar
Acetic Acid crude
Methyl Alcohol
Acetone
Acetates of Lead Copper Iron &
Acetate of Soda
Grey Acetate of Lime
Formalin
Methyl Esters and Ethers
Acetic Acid
Acetone Oils
Acetone
Iodoform
Chloroform
Amyl Acetate
Acetin
Ethyl Acetate

The distillation of wood in Western Australia is a matter which should seriously be taken up. Over 500,000 tons of wood, exclusive of sawdust and rotten heart wood, are every year burnt in the waste fires of various sawmilling plants in the bush. Wood thus destroyed is absolutely lost, while, if submitted to destructive distillation, it would at once produce many valuable articles of commerce, and provide an avenue of employment to many men.

The diagram on another page shows graphically the principal by-products that are derived from the distillation of timber.

Within recent years many improvements have been made in the distillation process. The introduction of the modern oven retort in place of cylinders was a big advance. In the new form the wood on framed trucks is run into iron retorts 50 to 60 feet long.

A further improvement was the use of the Meyer tar separator, which very effectively washes out the tar and saves a distillation.

In most plants the wood alcohol is distilled as far as 80 per cent. crude spirit. This is sent to central refineries which have developed special plant for the distillation of refused alcohol, and which allows of the economic separation of by-products, formerly wasted.

What appears to be a very big step forward is the Poore process quite recently brought into use in England. This process is devised to deal with small pieces of wood or even sawdust. The design of the plant is a great advance on any previously erected. The acetic acid vapours are absorbed in towers by means of milk of lime, at a temperature at which the alcohol still remains a vapour. The alcohol is then separately condensed. In this way not only is a concentrated solution of acetate of lime formed, but a costly distillation to separate the acid from the alcohol is avoided. It is said that the yields of alcohol and grey acetate are increased 50 per cent., while the total costs are reduced by 15 per cent. If this claim is justified, the prospects of successfully establishing the industry in Australia are considerably increased. Steps have been taken to have trial distillations of jarrah and karri made by the patentee of the process.

Jarrah and Karri and their Varied Uses.

It is often difficult to impress people with the immense possibilities latent in the principal commercial timbers of the State. Both karri and jarrah have been so long and so consistently put to second and third rate purposes that there has grown up in many quarters an opinion that they are suitable for none other. Never was a greater mistake made. There are few purposes in construction, in arts and decoration to which timber may be put that cannot be adequately filled by either karri or jarrah. Abroad jarrah has been seen almost exclusively in the form of railway sleepers. Timber experts, recognising the high qualities of the wood, have marvelled that such a magnificent timber should be put to a purpose which is filled in other countries by second and third rate timbers. Nowhere in the world except in Australia are railway sleepers made of the country's finest timbers. In Europe, and in America for that matter, they do not always insist even that the railway sleeper shall be strictly rectangular. The half-round sleeper is in common use, and in France engineers do not even demand that the sleeper shall be straight. So long as the requisite superficies is presented to the ground and the requisite thickness present, French engineers are satisfied. They do not call for a perfect piece of the highest class timber.

In Western Australia in the very first days of the Colony and for a couple of decades after, jarrah was to all intents and purposes the only building material used. Every one of the first buildings in Perth was of jarrah. The first courthouse, the Government offices, and Government house were all built of timber cut almost on their sites. The early buildings were roofed with rushes, and a little later the split sheaoak shingles came into vogue, and later on in the fifties sawn jarrah shingles were used. It followed, of course, that the pioneers used jarrah for furniture-making, and it continued to be so used until the cheaper but obviously inferior soft-woods ousted it. The first bridges and jetties were built of jarrah, just as they are at the present day, and some of these earlier structures are quite as good as when they were opened. Western Australia had a splendid opportunity of following in the wake of the United States and Canada and developing a local architecture, but it missed that opportunity, and took to the brick structure modelled on purely English style. In America and Canada whole cities are built of native woods. In others the residential quarters are entirely of timber, and in every case a special architecture has been developed, and the

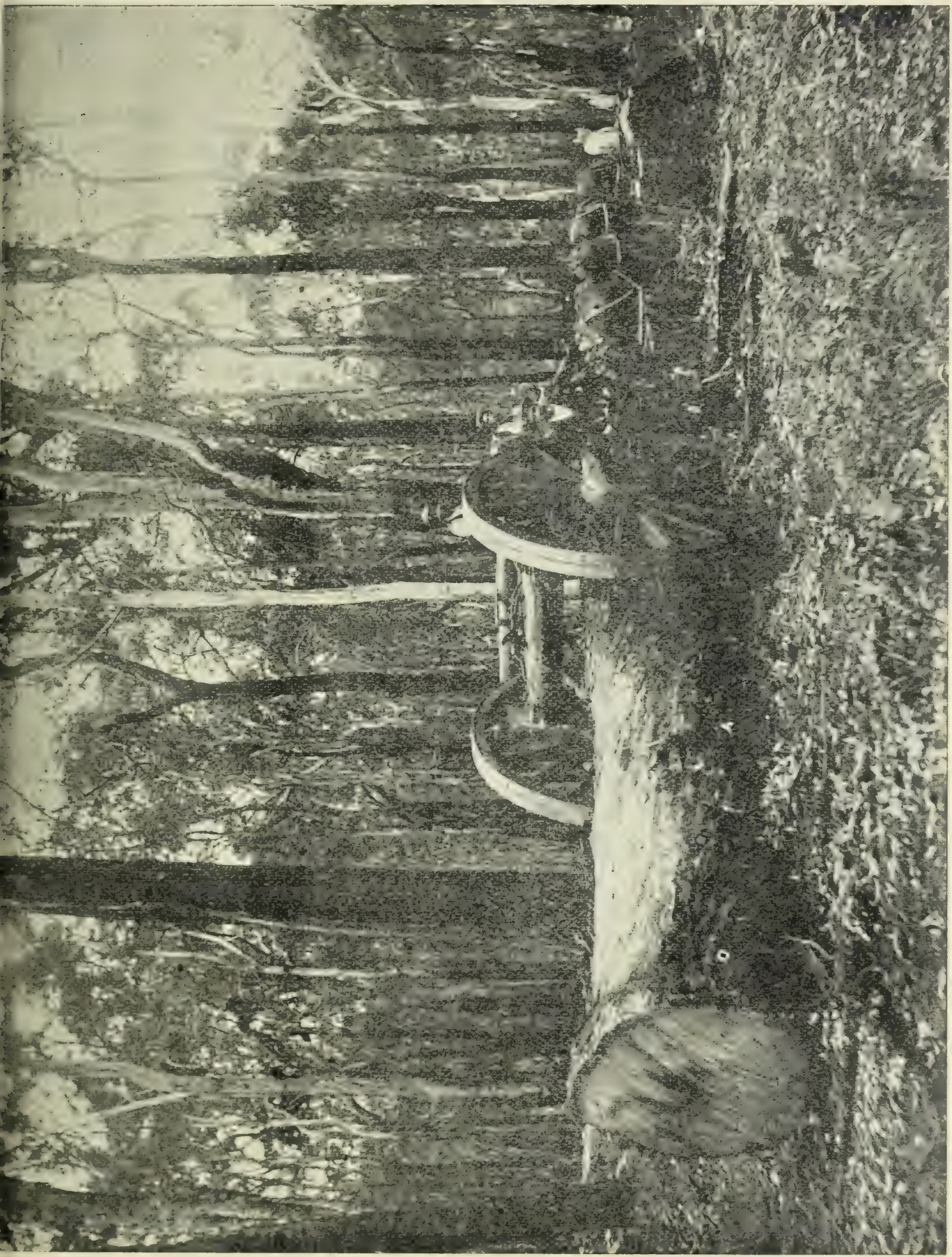
American wooden house of to-day is as commodious, ornamental and convenient as one built of stone or brick. Such a desirable state of affairs might have existed in Western Australia had it not been for an unreasoning adherence to British traditions. Again, municipal authorities in Western Australia have banned wood as a building material for outside walls and roofs on the alleged ground of fire danger. No sufficient proof that such a danger exists to an alarming extent has been adduced. Canada, for example, has given a scant reception to the fire bogey and; when one remembers that Canadian woods are all soft and many of them resinous and therefore readily inflammable, and that Western Australian timbers are all hardwoods with an unusual ability for resisting fire, the conclusion cannot be avoided that the civic authorities of the State framed their by-laws banning wood without due consideration.

In England the necessity for the rapid erection of a great number of houses for returned soldiers has led to a reconsideration of the question, with the result that the Board of Health has authorised the construction of buildings of wood. If the civic authorities of Western Australia will once more follow the lead of Great Britain, then we may hope to see here in the near future large numbers of fine residences built entirely of native timbers.

In building construction jarrah and karri are being employed in increasing degree where great strength is required. In many of the large buildings in the metropolitan area, warehouses and the like, native wood is being preferred to iron or steel for beams and supporting pillars. In the event of fire occurring in a warehouse fitted with metal beams and supports, it is more than likely that under the strain of an intense heat these will bend or break or buckle. With jarrah or karri the case is entirely different. The timbers char only to a limited extent, and continue to do their work.

For internal fittings jarrah and karri are being recognised as eminently suitable timbers. In some of the new office blocks in the City of Perth they are used exclusively in staircases, wainscoting, flooring, and panelling. Rooms so fitted present a remarkably handsome appearance, the rich tones of the timber enhancing the beauties of the pattern and design. For the manufacture of furniture of the highest class jarrah is now largely used.

In 1919 an *exhibition* of Western Australian timbers in a raw condition and manufactured was held in Sydney, and attracted a great deal of attention ; more particularly was this the case as regards the furniture. Messrs. Millars' Timber and Trading Company exhibited a very fine pedestal reading table, an elaborately carved cabinet, a sideboard, a hall-stand, and a mantelpiece, as well as some splendid wall panelling, all of jarrah. The Forests Department, in addition to raw products, showed a table of banksia and another of redgum ; the Railway Department of the State sent some tramcar seats of banksia, a number of beautifully marked sheoak panels, and a couple of wagon under-carriages of tuart and wandoo.



Hauling Jarrah Log.

A notable feature of this exhibition was a panelled room of jarrah, containing a table and suite of furniture also of jarrah. The whole of the timber of this room and the furniture was made from wood which had been kiln dried. This room was a striking illustration of the capabilities of jarrah as a furniture and decorative wood.

The Sydney exhibits were sent to London, where they were shown at an exhibition of the woods of the British Empire, and attracted much attention ; and in 1920 a somewhat similar collection was shown at the Peace Exhibition in Adelaide. Wherever jarrah and karri are shown in furniture or artistic form, they always command the admiration of the beholders.

The war has had this, among other effects, that while prior to 1914 few, if any, of the furniture makers in Perth used jarrah and karri in the trade to any extent worth mentioning, at the present time both these timbers are in active demand, and in every furniture warehouse suites and other articles of household furniture may be seen constructed of jarrah or of karri or other native timbers. Another result of the war is the discovery that karri is a first class cooperage material. Casks of this timber are now beginning to be made, and it is hoped that the demand for it for cooperage purposes will steadily grow.

Wooden Roofing.

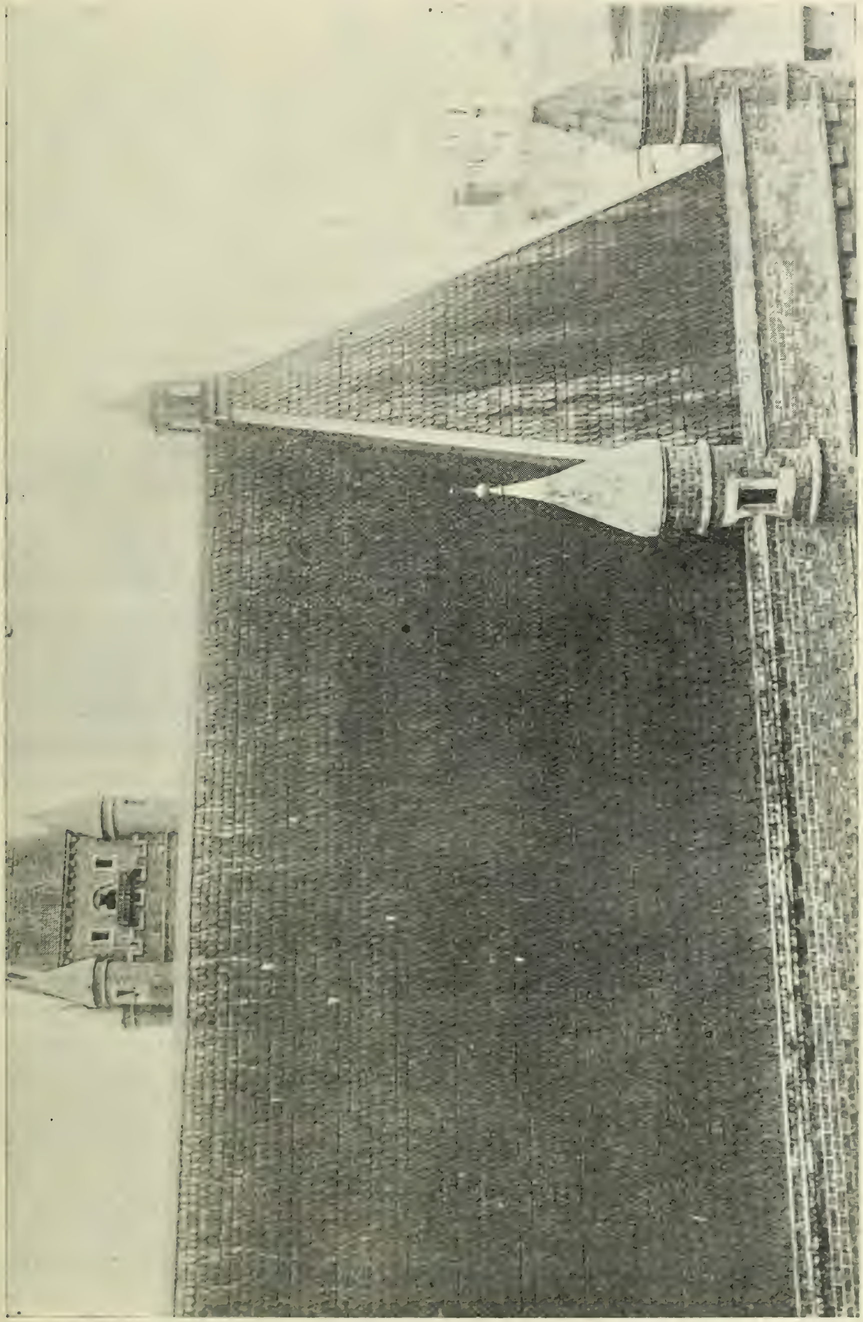
The history of roofing in Western Australia is not without interest. The first settlers at Fremantle and Perth, knowing nothing of shingles, but being well acquainted with the picturesque and efficient thatched roof so common in English country districts, looked round for a thatching material, and they discovered a very suitable article in the sedges and rushes to be found along the banks of the Swan River. The first Government House in Perth, the first Court House, and the first Church had rush roofs. Long before the first decade of the Colony's existence had passed, the settlers, through communication with New South Wales, had learned something of the art of shingling, and they found materials for its practice in abundance at their hands. In Perth and Fremantle jarrah was the material used almost invariably for the making of roof shingles. It was sometimes sawn, but more often split.

The life of a jarrah shingled roof which receives ordinary care and attention is marvellous. There are buildings to-day in Perth covered with shingles which have been in position more than half a century. The Town Hall of Perth, a fine and characteristic specimen of early colonial architecture, is covered with a roof of sawn jarrah shingles, and is still faithfully doing its appointed work. The roof was put on in 1870. In the country districts settlers shingled their roofs with the timbers that they found in the immediate neighbourhood. The whole of the West Australian eucalypts can be used for shingling, although it goes without saying, some are distinctly better for the purpose than others. Sheaoak is decidedly the best shingling timber of the State, and has been very extensively used. It splits well and is easily put on. With the advent of galvanised iron, shingled roofs in the town ceased to have a monopoly, and prior to the war the shingle was used to a comparatively small degree even in the country districts. But the increased price and scarcity of roofing iron again attracted attention to wood as a material for covering roofs, and the trade in shingles has experienced a considerable revival. Within the war period a good number of forms of wooden roof covering other than shingles have been put upon the market, the claims of each being duly set forth by its projector or inventor. In most of these new forms of roofing the longitudinal board is used with various ingenious devices for making the joints quite tight.

There is no valid reason why wood should not be much more largely used in building construction in Australia than it is, more particularly in the case of dwelling houses. In the United States and Canada wood in building construction is used to a very much larger extent than here, and in those States where the forest areas are large whole towns are built of wood, the buildings being designed in a manner which makes them both attractive and picturesque. In Western Australia wood as a roofing material in the larger towns is now prohibited by the local governing bodies, the reason given being the danger from fire. It seems strange that Australian civic authorities should be obsessed by the dread of fire, while similar authorities in America and Canada have no such dread. And the case is more remarkable when it is remembered that the hardwoods of Australia are much less inflammable than the softwoods of the American continent. In the country districts of Western Australia the wooden shingle, either sawn or split, has been within the last year or two used quite freely. It is cooler in summer than iron and it is warmer in winter, and the wooden covering can be put in position at something like half the cost of iron at its present price.

SHINGLES.

It has already been stated in this book that the Australian, when it comes to timber, has an extraordinary fondness for the imported article. One could understand this if there were no native timbers of any consequence in Australia, but, with wood second to none in the world, both plentiful and conveniently situated, it is hard to understand his neglect of them. This reproach, it is fair to say, applies with greater force to the towns than to the country. The settler in the bush finds himself, through a variety of reasons, compelled to use local timber, and he does so with a fair degree of consistency. His house, for instance, is usually of the local hardwood. In earlier times, he not only made his walls of wood, but was content with the convenient and picturesque shingle roof. But the time came when the building market was flooded with corrugated iron, which was easier to put on the roof than shingles, cost little more, and was represented as being in every way superior to the wooden covering. In the towns people of later years have gone in almost wholly for iron roofs, and they have shown their contempt for local products by using door and window frames imported from Scandinavia and America, where many of them are made by prison labour. As a matter of fact there is no purpose in domestic building construction for which we have not a suitable native timber. When it comes to roofing, there seems to be at the present day every hope that the despised shingle will again come into general use. The corrugated



Shingle Roof of Perth Town Hall (Jarrah).

iron sheet is now a scarcity in the market, and its price is such that a shingled roof, which will last as long as iron and cost less for repairs, can be put on for the same price.

In towns the questionable taste which prefers iron to wood as a roof covering has unfortunately been supported by the local authorities. These worthy gentlemen, in their ignorance of the real conditions, have brought into force building regulations which ban wooden structures. The reason they give for this is the danger from fire. Now the hardwoods of Western Australia are much less inflammable than the softwoods of America and Canada. Still the American and Canadian authorities have not permitted their imagination or outside influences to shake their decisions, and whole cities are built of wood, and fear of conflagration does not hang over the citizens.

In 1906, the then Minister for Lands and Agriculture in this State had some notes prepared upon Western Australian timbers and their suitability for construction purposes generally. From these the following sentences are taken :—" The British Fire Prevention Committee made some careful inflammability trials with jarrah and karri timber a few years ago, with a view to obtaining reliable data as to their fire-resistance capabilities, when severe tests were applied. The results were regarded as generally satisfactory, and as indicating that a building constructed of jarrah or karri would be unusually resistant to fire, especially in the case of floors and flooring beams. Tuart is about equally resistant, while blackbutt is especially mentioned by the State Royal Commission as being notably non-inflammable.

To this British evidence on the fear of fire danger it may be well to add some American evidence. Two years ago fire tests were conducted at Birmingham, Alabama, to determine the respective fire resisting properties of wooden shingles and substitutes made of various materials, regarding whose fire resisting properties the inventors made lavish claims. Here is an extract from the report on these tests :—" Another phase of the contest involved the placing of a shovelful of live coals upon prepared roofing and upon a square of the same dimensions of wooden shingles. These were set on fire and the " Empire " paint burned with considerable smoke. The prepared roofing burned over 30 minutes, blazing freely, and the fire ate through it to the wooden decking beneath, when it was checked ; but the substitute was consumed. The fire immediately over the wood charred them, but the shingles themselves were not burnt through and did not blaze at any time." It must be recollected that the shingles submitted to the fire test at Birmingham were all softwood, and it needs no arguing to make clear the point that our hardwoods have stood the same test even better.

Owing to the high price of iron, builders and those interested in house property are seriously turning their attention to the too long neglected shingle. Hitherto the shingle used in Australia has been of about 16 inches by 4in., put on with suitable weather lap. It need hardly be said that to have a successful shingle roof it is essential that the pitch should be much higher than that adopted when iron is used—not less, say, than 40 degrees. Complaints in the past about shingled roofs have arisen almost wholly from two causes, insufficient pitch of roof and the use of the wrong kind of nails. The common wire nail is fatal to a successful shingle roof. The acid which is present in some of our woods surrounding it corrodes the nail, which becomes defective, and mischief sets in. It is essential in shingling to use a good galvanised nail. But there are other forms of wood roofing besides the small shingle, and several of these are of Western Australian invention and design. In these the pieces of timber used are very much larger than the ordinary shingle, and by ingenious methods of preparation and fastening a perfectly water-tight covering is made.

Post-war conditions will demand the consumption of local products to a much larger extent than was the case in pre-war days, and the adoption of the shingle is a step in this direction. In a country where timber is so abundant there is really no excuse for preferring the gray drabness of iron to the appropriateness and beauty of a properly constructed wooden roof. The days to come are to add a new significance to the familiar phase, "support local industries."

Wooden Houses.

For a considerable time the Forests Department of Western Australia has been advocating the adoption of indigenous timbers as materials for house-building. It has been pointed out that in the early days of the State's existence no other material was used than wood, and that residences constructed were not only commodious but elegant. Some of these still remain, and are eloquent testimony to the durability of the native timber and to its adaptability for house construction. It has been pointed out that in Canada and in those American States which possess an abundance of timber whole towns or quarters are built of timber, and that each of the countries named has developed an architecture of its own, specially designed for wooden structures. But the Western Australian is possessed of a deep-rooted conservatism. He is full of English traditions, and those traditions indicate brick and stone as the only possible materials for building and he uses them accordingly. Civic authorities have assisted in this banning of wood by passing by-laws which prohibit timber in outer walls or roofs within municipal boundaries. Here also they followed English precedence, for shortly after the great fire of London English civic authorities prohibited wood on account of fire danger.

Settlers in Canada and America, even though the timbers at their disposal are almost entirely softwoods, soon learned that the fire danger was grossly exaggerated and that with ordinary precautions a structure of wood did not contain the element of danger to an extent that made the use of timber impossible. Be it remembered, too, that in Australia all the woods are hard and much less inflammable than those of the American continent.

Under stress of circumstances the British authorities have reconsidered the old judgment about wooden structures, and to-day wooden houses are being built in hundreds all over Great Britain. The idea of building in wood in England owed its inception in a great degree to the fact that a wooden structure could be put up much more quickly than one of brick or stone. A dearth of houses to meet the wants of returned soldiers gave form and direction to the question, and the Ministry for Health, after due inquiry, not only sanctioned the use of wood for the purpose but agreed to give a subsidy of £150 on every house built. Since then private citizens and firms have taken up the matter, and wooden houses of the cottage and bungalow order are being erected.

The question of durability finds a convincing answer in the wooden structures at Chester, Stratford on Avon, and elsewhere, where for centuries wooden houses have existed and been occupied. In the House of Commons in the middle of November, 1919, Dr. Addison, Minister for Health, presented a new scheme for the speedy erection of houses. Briefly put, the new proposals are as follows :—

1. Building by local authorities is to be encouraged by an easing of the financial terms ;
2. Private builders ought to be encouraged to build houses by a subsidy on all houses built within the ensuing 12 months. The maximum subsidy is £150 a house.
3. Luxury building, which is absorbing so much labour at present, is to be checked.
4. Labour.—Proposals are to be submitted to the building trade for quickly training the new men.

A number of firms have submitted proposals for the construction of timber-framed bungalows and also for buildings of more ambitious design. In short, timber as a building material for residences is again coming into favour in England.

Climatic conditions, if no other, suggest that timber is a much more suitable material for house construction in Western Australia than the brick and stone of everyday use. The matter is one which the sawmillers of Western Australia might well take up. They are now suffering from the restricted foreign market owing to inadequate shipping facilities. An outlet for the product of the mills might be found in building construction, but before anything can be done it will be necessary to educate the public on the question and to show them that structures of wood can be made as commodious, as ornamental and as picturesque, as those of other materials.

Boat and Ship Building in Western Australia.

A Story full of Interest.

The development of the Colony of Western Australia in its earlier decades was intimately associated with the building of boats and ships. The conditions were such that water carriage was not only the most economical, but was indeed the only method possible. The pioneers settled themselves in the districts watered by the Swan, the Canning, and the Murray, and it was only to be expected that the rivers became the highways. For years the Swan was, to all intents and purposes, the only " road " from Fremantle to Perth and Guildford, and the upper reaches of the river. Few ever thought in those early days of covering the distance between Perth and Fremantle by any other way than boat. The river was so well recognised as the best and most convenient highway that sailing boats plied regularly between the capital and the port, their hours of departure being fixed and duly advertised. And the colonist, finding that jarrah was a splendid wood for house construction, argued that it would be equally successful in boats and ships ; they used it accordingly, and experience soon made it certain that, as a material for marine work, jarrah was an eminently suitable timber. Before the Colony had been ten years in existence boat and shipbuilding had become its principal secondary industry. There were building yards in Perth and Fremantle, and on the Canning and the Murray, and at Bunbury. Albany also had a busy yard, and there some of the finest vessels ever launched in Western Australia were turned out.

Necessity, if nothing else, compelled the early colonists to engage in big boat and ship building ventures. Ships from England arrived only at irregular intervals, and, as no foreign tonnage was available for local coasting trade, ships had to be built here. The fine part the early shipbuilders played in the development of the country deserves the lasting gratitude of all those who came after them.

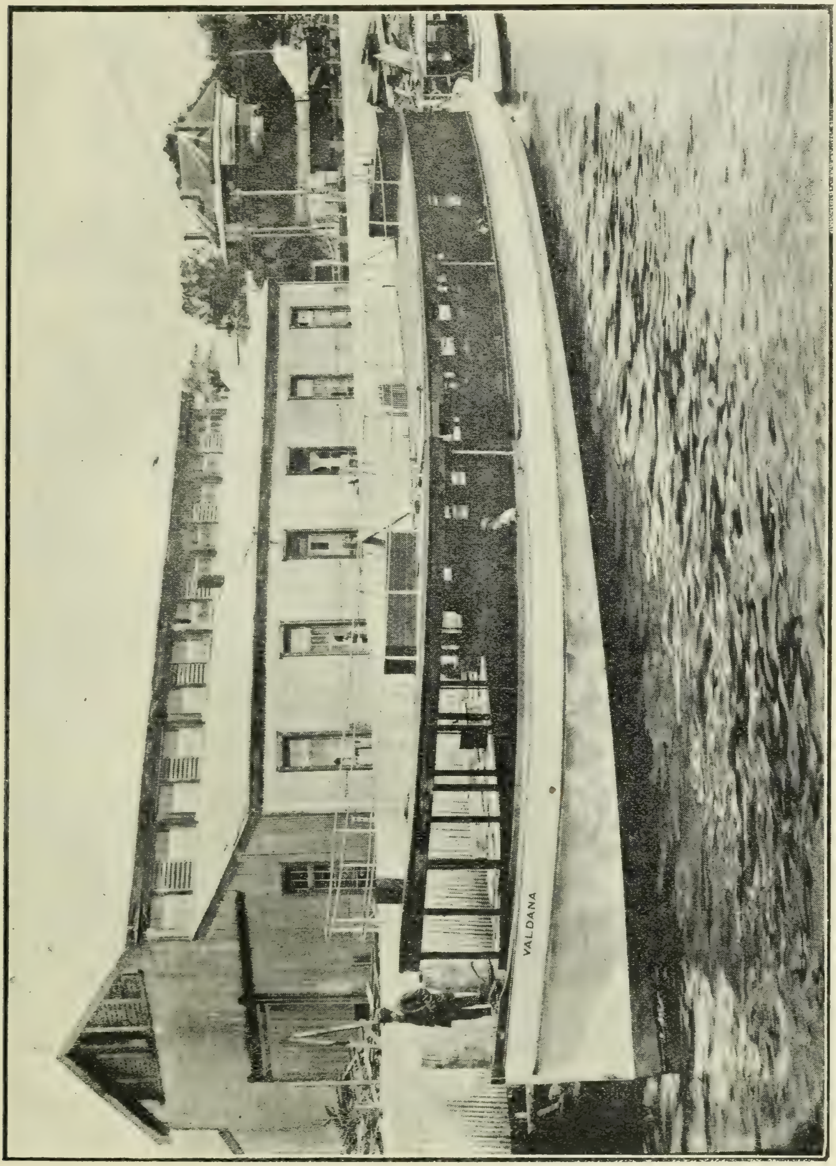
Boat and shipbuilding were among the earliest purposes for which local timbers were used. The circumstances of the young Colony made it quite impracticable, even if it were desirable, to import foreign timber for the many purposes for which it was required. The demand for ships of various sizes for use in the river and around the coast was very urgent. But it is evident that the colonists in the opening years of Western Australia's history had not forgotten the English oak as a shipbuilding material, for very early it is announced that seedlings of English oak have been raised at the Botanic Gardens in Perth, and may be had by the settlers who desire to grow oak trees. The effort, however, seems to have died a natural death, for long before the seedlings could become trees from which shipping timbers were possible, the value of native timbers for shipbuilding purposes had been discovered, and the idea of growing exotics on an extensive scale was abandoned. The earliest printed reference to shipbuilding occurs in March, 1833, when a "craft" was said to be on the stocks in Perth for a Mr. Lukin, and was to be used as a whaler, with Albany as the centre of its operations. This year a "boat" was built at Perth by a Mr. Edwards for Moore & Hunt, and was fitted out for a sealing cruise around the islands in the neighbourhood of King George Sound. Albany in these early days seems to have been the head-quarters of the whaling industry, although at a subsequent period Fremantle was the home of several very promising whaling enterprises. Albany in due time built its own vessels for whaling, and towards the end of 1834 a Mr. Dring launched two at King George Sound. The largest ship up to that date built on the Swan was the Lady Stirling. She was constructed wholly of native timbers, but, unfortunately, four months after her launching she was seriously damaged while trying to cross the bar at the entrance to the Swan, but was afterwards repaired. It should be mentioned that overseas ships did not enter the river to discharge their cargoes, but according to the report, any loading and unloading of cargo was done by medium of boats. Cockburn Sound was in these days the principal export harbour of Western Australia.

The River Murray was also the scene of shipbuilding operations, and in 1846 a schooner of 150 tons with a keel of 75 feet was built there. Another vessel with an interesting history was the "Emma Sherrett," a schooner of over 90 tons, which left Fremantle for the Mauritius. No details of the cargo are available, but the vessel itself was built at King George Sound. In 1845 the "Thetis," schooner, was launched at Fremantle, being the fifth vessel built up to that year; at the time of her launching two more were in course of construction. One of these, the "River Chief," was to be 220 tons burthen, and was intended to sail for London freighted with local products. Towards the end of the year she had sailed, taking amongst other cargo 50 tons of sawn timber and 21,000 shingles.

There were enterprising people in the Colony in the late 50's, and in the matter of shipbuilding they were not content with simply constructing vessels to carry away the natural resources of the Colony; they felt their isolation in the matter of vessels from overseas, and in 1847 it was seriously considered whether it would not be well to extend the shipbuilding industry in order that imports might also be landed in the Colony from Western Australian bottoms. Bunbury, too, had its shipbuilding yard, and up to 1850 there had been built at Bunbury these vessels :—"Emu," schooner, 20 tons ; "Gazelle," 18 tons, built a mile up Preston River ; "Frolic," 16 tons ; and one schooner of 50 tons then being built. In 1857 "The Pioneer" steamer was built wholly of local timbers, and commenced to make trips to Guildford ; in the same year the "Lady Stirling" was engined for use on the river. The river, owing to the absence of roads for a generation after the Colony's

Schooner "Alto," built of jarrah.

foundation, was the great highway between the port and the capital. The whole of the barges and boats used for passengers and goods conveyance between Fremantle, Perth, and Guildford were built of local timbers, and many of these small vessels were very fine specimens of the naval constructor's work. Experience soon taught the early colonists the purposes for which the various woods were more particularly suited, and boat and ship specifications often bear evidences of this. For



Motor Launch built of Jarrah.

instance, in 1859 the Commissary General calls for tenders for two six-oared whale boats for service of water police to be of "Singapore pine" keel, stem, and stern post; gunwale, thwarts, rising keelson, and bottom boards to be made of mahogany; knees of seasoned banksia timbers, oak, or hickory. The Singapore pine here mentioned is presumably the pine now almost exclusively used on the North-West coast for the manufacture of cases for pearl shells.

With the coming of steam and with iron and steel replacing wood in the world's shipyards, the building of wooden vessels gradually declined. But the industry is by no means extinct. Most of the pearling schooners and luggers on the Nor'-West coast are built in the State of timbers grown in the State, and the same may be said of the hundreds of fishing boats at the various centres.

The revival of wooden shipbuilding is a matter which might well be seriously taken up in Western Australia. There is still work for wooden ships to do. Much of the carrying trade on the American coasts is done in wooden bottoms, and Scandinavia finds constant employment for large numbers of wooden vessels.

A JARRAH MOTOR LAUNCH.

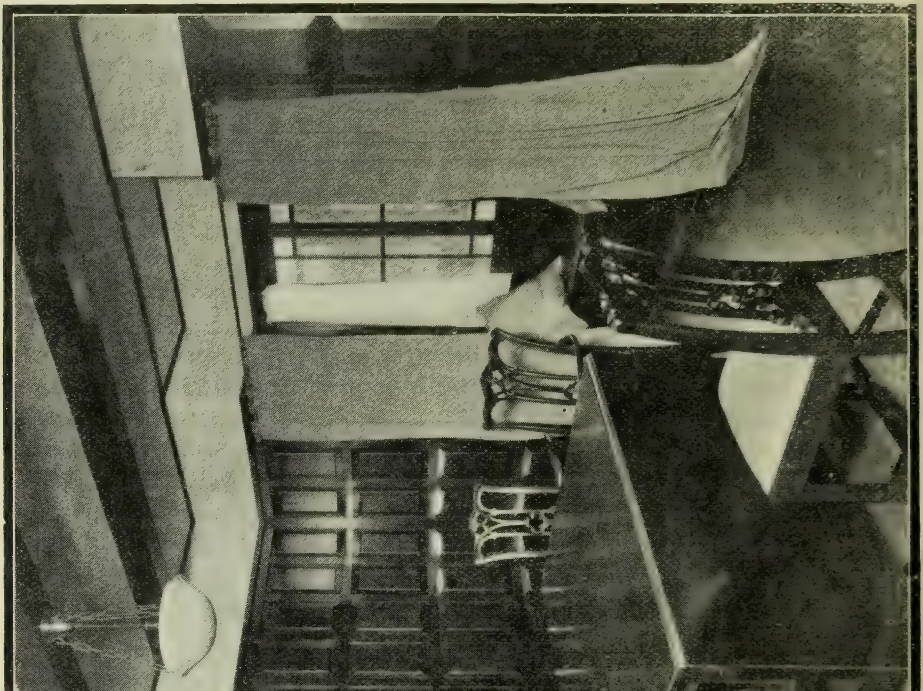
The illustration on preceding page shows the new motor launch "Valdana," built by Messrs. Lawrence, of Perth. The craft is 67 feet in length with a beam of 13 feet 6 inches and a depth of 5 feet. The hull, including the main and flying deck, is wholly of jarrah. The suitability of jarrah for shipbuilding purposes has been recognised ever since the foundation of the Colony, and a very large number of vessels constructed wholly of it were launched in the earlier decades of Western Australia's existence. Nearly half a century ago jarrah received recognition from the British Admiralty, and about the same time it was placed on Lloyd's List as a timber suitable for shipbuilding.

Timber in Art.

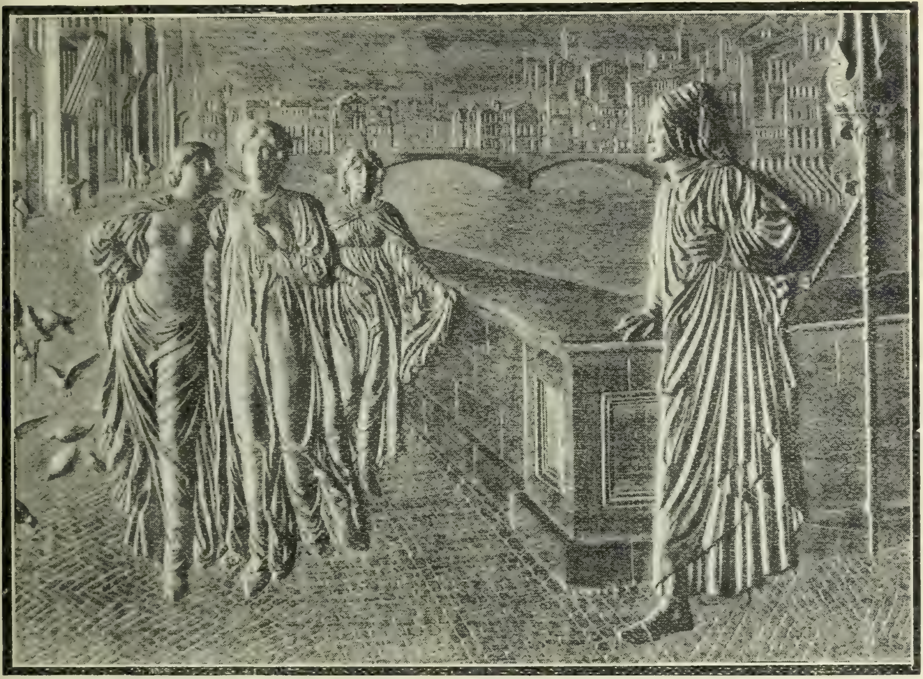
It is probable that man had advanced but few steps on the difficult athway of civilisation when he began to imitate natural objects in uch materials as were at his disposal. And it may be taken for granted hat wood was not the first material he made use of in giving expression o his initiative and artistic instincts. Stone or clay were in all likeliood the vehicles he employed in his earlier essays. Wood necessitates he use of cutting implements that were not at his disposal in the stone nd earlier ages. Rude carvings on stone and crude representations of nimals in clay have been found in situations which clearly indicate that hey were fashioned long prior to the neolithic period. Not till the Iron Age was working in wood in any but the most primitive way possible. With tools by means of which timber could be cut with ease and comparative accuracy, man found opened to him fresh and hitherto undreamed of possibilities for the free exercise of his artistic and imitative nstincts. The peoples of distant ages and of nations which have long ago been swept into oblivion by time's effacing finger practised carving on wood, and specimens of their handiwork, rescued after having been hidden for many centuries, reveal a skill which has scarcely been surpassed in later times. In ancient and ruined temples and in palaces, in halls of justice, and in the tombs of kings and warriors have been found examples, many of them as marvellous in the effectiveness of their execution as they are bold and original in conception.

In Great Britain, carving in wood was an art extensively practised, more particularly in connection with ecclesiastical decoration and furniture and panelling. The old cathedrals, abbeys, and monasteries were rich in examples of carving of the highest artistic merit, not only in altars, altar and rood screens, pulpits, lecterns and fonts, but in chairs and other furnishings and in ceiling beams and ceiling. Many of the specimens in such of the old religious edifices as still remain display a delicacy of touch, a wealth of conception and fancy, and a skill in execution rarely equalled in these latter days. Carved work similar in character and style, although different in subject and object, is to be seen in the baronial mansions erected in Great Britain between the 12th century and the later decades of the 17th century; while the furniture in these, and, indeed, in almost every dwelling erected during the centuries referred to, exhibits equal richness in decoration. To the artistic fervour of the craftsman from the Norman to the Georgian periods, the British people owes the many "styles" of furniture, of which imitation and reproduction are now being constantly put on the market. The cabinet-maker of the earlier generation worked under conditions which favoured the development of the artistic faculty, and giving it free scope he lifted his craft into the regions of high art.

For half a century at least after white people began to settle in Australia, the severely utilitarian character of the work urgently requiring attention from the settlers precluded considerations of decoration. Those of them who were gifted with artistic leanings satisfied them with importations from Great Britain. It is only of comparatively recent decades that the beauty of many Australian timbers and their eminent suitability for decoration have been realised. With realisation, however, there came, happily, a patriotic desire to use them, and to-day,



Panelled Room and Furniture, all of Jarrah, exhibited in London and in Sydney in every State, indigenous timbers are being employed for the best class of work, and this appreciation is exemplified in the increasing degree in which furniture made from native woods is being manufactured. In Western Australia among the timbers now greatly in favour for household furnishings, staircases, panelling and the like, are jarrah and karri. The fine " figure " also of sheoak, banksia, native-pear and other timbers has especially recommended them for decorative purposes. Sheoak, which provides the best shingle for roofing, is also found to make up into articles of furniture of distinctive and attractive beauty, and the same may be said of banksia, which, to many, in the past, has had no value except as firewood. A fine example of carving in jarrah of high artistic merit is reproduced above. It is a reproduction of the picture representing the meeting of Dante and Beatrice on the bridge over the Arno at Florence, and is the work of Mr. William Howitt, of Perth, an artist whose skill has received wide recognition.



"The Meeting of Dante and Beatrice."
Carved in Jarrah by Mr. Wm. Howitt, of Perth.

Whatever may be the unexpected phenomena of the future, whatever changes may take place in the vehicles employed in giving expression to the artistic sense, it is certain that the art of the carver in wood will remain, for that art has been practised since the dawn of civilisation, and the material it calls for is found in every country.

Forest Fires.

Of the many problems which have to be dealt with by the forester, there is none which is so constantly with him as that of fire. Its shadow is always over him : its dread possibilities are ever present in his mind. Even when he has at his disposal, or has pressed into his service, every device, every scheme, and every precaution which experience has proved to be more or less effective, he is still ill at ease. When, from one cause or another, he is without fire-fighting machinery of any kind, or possesses it only to a totally inadequate extent, his cares become proportionately increased. It may with perfect frankness be admitted that there is no such thing as absolute prevention in the matter of forest fires. But it is possible to prevent the vast majority of them—preventible and unavoidable alike—to minimise the damage caused by them, and by so doing preserve a nation's timber wealth for the use of posterity. The experience of every country whose forests are of sufficient extent and value to entitle them to be regarded as national assets stands out as proof that cannot be shaken. In America reckless exploitation and forest fires reduced the available area of saleable timber to such an extent that popular alarm was created. Nearly every State in the Union has now its legalised code of fire protection regulations, and over all there is the Federal Act (the Weekes Act) dealing with the subject. The result has been that the future of America's great timber industry has been furnished with the main element which goes to ensure permanency. Canada was even in a worse condition than America before she awoke to a realisation of the position. It is estimated by competent authorities that two-thirds of Canada's forest resources have been destroyed by fires—most of them preventible. But conservation and prevention are now in operation in all the provinces, British Columbia leading the way. In Canada, however, the whole burden is not on the shoulders of the Government. The lumbermen, the men who are earning their living in the forests, are alive to the fact that their own future existence is at stake, and they energetically co-operate with the State officials in the great work of fire prevention and control. In the "Canada Lumberman" of 1st February of this year the following paragraph appears.:—

> In view of the success of co-operative fire protection in the province of Quebec between the Government, the limit holders, and the private owners, the Commission offers the suggestion that the formation of a similar association be considered by the limit holders and by the Government of Ontario.

A similar scheme of co-operation for mutual relief from a common enemy has been agreed to by the lumbermen on the Pacific coast and the Government of British Columbia. The general question of fire rotection came up for discussion at the Canada Lumberman's annual neeting in February last, and the Hon. C. Howard Ferguson, Minister f Lands, Forests, and Mines, speaking about fire protection, said :—

> In order to work out the financial aspect of the question satisfactorily they ad devised a plan under which the lumbermen would pay little, if anything, nore than they were paying to-day. He thought that the lumbermen should be repared to pay from one-quarter to one-third of the cost of fire protection in ntario, but he desired to take on himself and the department entire responsiility for the administration of the service. Taking the figures in the records of he department, he thought that about 1 per cent. per acre would produce just bout the amount the lumbermen were spending to-day on fire protection.

Effect of Fire on Jarrah Forests.

Here, too, is the testimony of a British Columbia authority :—

> Experience had proved conclusively that the co-operative system of fire fighting was the strongest and most efficient when the drought period came and nen had to be gathered and hurried to fires. During the season, 457 fires had been extinguished. A number of the companies were doing a great deal to prevent fire.

In South Africa fire prevention has followed as the natural result of putting the forests under scientific management. Many outbreaks of fire occur, but they rarely do much damage. In Australia, the case is quite different. The late Sir David Hutchins, who made an official inspection of Australia's timber resources, some two years ago, crystallises the Australian position thus :—" If there were no forestry in Australia beyond mere fire prevention, the benefit to the country would be incalculable. This is almost a truism to anyone who has travelled far through the forests of Australia ; but, on the other hand, few Australians will admit that the fire protection of the forest is practicable. They have not travelled through the forests of countries with climates like Australia, and gone round with the forest officers of those countries to see how their fire protection is managed . . . . I am in a position to assert positively that the control of fire in Australian forests is solely a matter of organisation ; and I have spent a lifetime doing fire work in India, in South Africa, and in British East Africa ; while my visits to Southern Europe have shown me how fire is successfully controlled in forests there."

Possible cause of apathy.—It may be that some of Australia's apathy in the past is due to the prevalence in some quarters of a belie that a fire through the bush is a good thing. The contention has no solid basis in fact. It arose probably from observing that fire is in due time followed by an ample growth of succulent feed for stock. Tha is not denied, but the forester affirms, and there is no gainsaying the weight of his statement that the new feed is purchased at too great a price—at a price, in fact, which eventually means timber bankruptcy The evils to a forest resulting from fire are many. It will be sufficien here to summarise only a few of them. Let it be understood, in the firs place, that the " clean-up " of undergrowth (which a fire effects) is not a good thing. A beautiful park-like expanse with trees symetrically arranged is not a natural forest. A soil " choked with undergrowth " is the prope condition of a forest until the undergrowth is killed down by the clos growth of timber, which it is the forester's craft to produce. The decaying ground herbage, undergrowth, and fallen leaves form the open rich vegetable compost—the humus—which is essential to a healthy forest Fire destroys this. In the wake of fire come crooked young trees with short boles and double crowns producing at maturity relatively littl good timber. Large trees are defoliated, " greedy growth " occurs gum pockets are formed, and the timber value is depreciated. All who have travelled through the jarrah forest will have noticed areas burn the year before, where the crowns of the trees are leafless, and the stem covered with a growth of little green shoots. These are the greedy branches. Each one of these falls off in a year or two, and leaves a gum pocket. More serious still is the destruction of seedlings and saplings If a timber industry is to prosper, there must be a steady rotation o mature timber. Fires render this impossible. There are other evils, but enough have been named to demonstrate that the fresh feed following a fire is purchased at an enormous price, a price indeed which no country, whatever the area of its forest, can afford to pay indefinitely. The circumstances under which a first fire may perhaps do little harm or indeed be of advantage are few, and appear to be limited to country that has been cut out. A first fire in such country may assist the germination of dormant seeds, but subsequent visitations by destroying seedlings and humus can have only an ill-effect.

PROTECTIVE LEGISLATION AGAINST FOREST FIRES.

In every country where the national forest property is administered under legislative enactment, provision is made for the punishment of persons illegally setting fire to forests or using fire in such a way that damage to the forests results. The fire evil in the United States and Canada has affected the national forest property so disastrously that the penalties for wilfully or carelessly causing fires are severe. So gravely is the danger from fire regarded in the countries named that complete and elaborate measures for the prevention of fire are in existence, including patrols by aeroplanes.

The Forests Act of Western Australia contains the following provisions dealing with the subject :—

> If any person—
>
> (*a*.) lights, kindles, or assists to light or kindle, or aids or abets another person in lighting or kindling any fire within the boundaries or within twenty yards of any boundary of a State forest or timber reserve ; or
>
> (*b*.) leaves, without taking due precaution against its spreading or causing injury, a fire lighted or kindled by him as aforesaid, or in the lighting or kindling of which he has aided or abetted ;
>
> and in either case any forest produce is burnt or injured, or is in danger of being burnt or injured, such person shall be guilty of a forest offence, and liable, on conviction, to imprisonment for not exceeding one year, or to a penalty not exceeding one hundred pounds.

A reward of not exceeding fifty pounds may be paid by the department to any person, not being a forest officer, who shall give such information as may lead to a conviction under this section.

In the event of a fire occurring in or adjacent to any State forest or timber reserve, a forest officer may call upon any person residing or working within a radius of five miles of the outbreak to assist in extinguishing the fire.

All persons who in response to such call shall render the assistance required shall be remunerated at the prescribed rate.

Any person who sets fire in the open air to any tree, wood, bush, or grass on any land contiguous to a State forest, or timber reserve, without giving notice of his intention to a forest officer so as to allow such officer to be present at the firing, commits a forest offence.

The officers of the Forests Department are, however, fully aware that summonses and fines, while most necessary to enable them to make examples of those who infringe the law, are only used as a last resource. They recognise that the people themselves must learn that the forests of Western Australia are their own heritage, and that to burn them is to destroy their own and their children's wealth.

FIRES IN EUCALYPT FORESTS.

The man who contends that a big blaze in a eucalypt forest does no harm because the trees continue to live and put forth fresh crown and a plenteous growth of sucker shoots may be dismissed without comment, as the damage done is apparent to every intelligent observer. There is, however, a specious contention which has become fairly universal in Australia and has even found official recognition. It is said that the only way to control the bush fire is to run a creeping ground fire through the eucalypt forest as frequently as possible and thus prevent the possibility of a big blaze damaging the forest. This end may be obtained, but at what cost ? Have we any reason for supposing that the food material of trees in Australia differs radically from the food material of trees on the continent of Europe ? European experience has proved conclusively that leaf mould and litter on the floor of the forest is indispensable to the successful growth of a forest, yet it is common practice to despise it utterly in Australia, and rule it out as of no account. To take a single instance : in the South of France *Pinus pinaster* was found to grow successfully on bare white sand which had been temporarily fixed by scattering brushwood and weighting it with spadefuls of sand. The cluster pine grew and developed into satisfactory trees yielding a valuable return of turpentine and timber. Happily the trees were too inflammable and the French forester was too well trained to eliminate fire risks by burning up the needles and branch wood as they fell. Instead, they established fire breaks and built watch towers so that serious fires are practically unknown. The beneficial result is now being felt, for the second crop of pines are growing more rapidly and developing into a better class of tree than the first. This is solely the result of fire protection and preservation of leaf and branch litter cast by the trees.

The above is an example of a forest grown under conditions very similar to those in many parts of Australia, where the trees have to contend with six months' drought each year, but, allowing that conditions in Australia differ enormously from those in Europe, the principle still holds. Our trees have deeper growing root systems, they depend more on the subsoil for sustenance and moisture and generally are highly adapted to stand xeraphytic conditions. Their bark is often very thick, enabling them to outlive a severe scorching in a fire, but observe next time you see a eucalypt of this type uprooted the immense number of small fibrous roots which are to be found at a comparatively shallow depth. The junction of the huge thick roots which are the more obvious is purely mechanical. It is the extreme ends of the small fibrous roots which are charged with absorptive functions. These small and delicate rootlets have no incentive to approach near the surface while the bush is repeatedly burnt, but once allow the leaf litter to accumulate and they will readily find their way up to tap the highly nutritious food supply which millions of bacteria combine to render available.

The highly developed xeraphytic adaptations of many of our eucalypts enable them to live under conditions which would mean certain death to a less hardy species, but we cannot expect them to grow at the same time when struggling against adverse conditions, as when, by efficient organisation, the forester can enable them to live under optimum conditions.

The more obvious evils of the burning of regrowths making every tree in the future forest a coppice shoot do not need emphasis. In calculating the age and increment of sapling growth, the number of times burnt and the years spent in putting on a new crown should surely be deducted from the total age of the tree.

Perhaps the worst illustration of this may be found in the jarrah belt of Western Australia, where comparatively steady fires run through the bush every three or four years. The jarrah forest continues to live and certain thickets of apparently good regrowths catch the eye of the visitor, but examine one of these thickets. Collectively it presents the appearance of a promising stand of young timber, individually there is scarcely a sapling to be found which one can feel reasonably assured will develop into a good mill log. But what of the older trees ? Recent measurements show that these are developing at a very much slower rate than has been believed in the past, and it can be quite logically postulated that repeated firing of the jarrah bush, whereby the top soil is baked hard and every vestige of humus destroyed, is slowing up the rate of growth of the jarrah. The cry that it is impossible to prevent and control fires in a eucalypt forest, whether it be stringybark, ironbark, or jarrah, is the cry of a small man faced with a big problem.

Fire-Resisting Qualities of Eucalyptus Timbers.

Many inquiries have been made into the strengths of Australian timbers, and into those imported from outside, and the results have been tabulated on many occasions, but so far no comparative statistics have been compiled touching the fire-resisting qualities of Australian woods as compared with the softer timbers imported so largely into the Commonwealth.

The subject is topical at this moment, for the reason that large sums are now being spent throughout the Empire on homes for returned soldiers. One effect of this has been that, in England at last the old bogey about the danger of wood for building construction in towns has been laid, for the English Health Department has sanctioned timber as a building material for War Service homes.

In London several fire tests of Westralia's principal timbers have been made, and the reports upon these are of interest, and there can be no question that the behaviour of these timbers under fire does not materially differ from most of the other hardwoods of the Commonwealth. The following notes give particulars of these tests :—

Reports on the fire of September, 1902, at the Victoria Docks, London, E., on the premises of the Acme Wood Flooring Company, Limited, in which large stacks of deal, pine, American redgum, and jarrah were involved ; and tests made by the British Fire Prevention Committee on the 29th January, 1902, and the 9th July, 1903, clearly demonstrate the fire-resisting qualities of karri and jarrah timbers.

The Fire at Victoria Docks.

The British Fire Prevention Sub-committee in their report of the Committee of December, 1902, on this fire, said, though the jarrah bore the brunt of the fire, as what wind there was blew in this direction, comparatively little damage was done to this pile, and this was confined to the North and West faces, the fire failing to penetrate far into the interior. Your sub-committee are of opinion that but for the resistance offered to the fire by this stack of jarrah, the conflagration would have assumed much larger proportions, as in the rear were large quantities of deals, and had they ignited the task for the fire brigades would have been far larger and more difficult.

"The Street," in its issue of October-November, 1902, in an illustrated article on this fire, said "The fire swept all before it until it reached the stacks of Australian hardwood. The fierceness of the fire met an instant check, and failed to lay hold of the close-grained wood, thus giving the firemen the first chance of really tackling the flames and eventually extinguishing them ; subsequent investigation showed that these wonderful West Australian woods were merely charred on the surface, and the large stacks remained intact. Inside the mill were several railway trucks loaded with hardwood blocks of the description used for public roads, ready for despatch to customers. The steel frames, springs, and wheels were all that remained of the trucks, but the contents were intact except for slight charring of the external layers of wood blocks. There can be little doubt that if the timber in the mill and in the yard had consisted wholly of Australian hardwood instead of deals and hardwood in juxtaposition, the fire would not have made much headway before being mastered by the brigade and the dock company's floating engines. After all, an actual fire is the best fire test, even though an expensive one for the moment."

The Tests of the British Fire Prevention Committee on Jarrah and Karri Doors and Jarrah Floor, January, 1902, *and Karri Floor, July,* 1903.

The aim of the committee, as set out in their prospectus, is "to obtain reliable data as to the exact fire resistance of the various materials The tests are of entirely independent character, arranged on scientific lines, but with full consideration for the practical purpose in view . . . . All reports on tests solely state the bare facts and occurrences."

In their report of April, 1902, the committee give the following particulars of certain tests of jarrah and karri :—

Fire tests Nos. 35 *and* 36, 29*th January,* 1902.—A 2in. jarrah four-panel (bead flush both sides) door ; a 2in. karri four-panel (bead flush both sides) door.

Objects of Tests.—To record the effect of a fire of one hour, gradually increasing to a temperature of 2,000 deg. F. (Note : 2,000 deg. F. was attained in 30 minutes, and the temperature remained between 2,000 deg. F. and 2,200 deg. F. until the end of the test). The fire was to be applied from one side, and the doors were to open inwards on to the fire side. The door openings were to be approximately 3ft. by 6ft. 9in.

Fire Test No. 37, 29*th January,* 1902.—A floor of jarrah wood, area 222ft. 6in., super. in the clear (10ft. by 22ft.) loaded with 232lbs.

per square foot in three separate loads of bricks, that in the middle covering an area of 47ft. 5in. super., and the two end ones 42ft. 8in. super.

Object of Test.—To record the effect of a fire of two hours' duration at a temperature gradually increasing up to 2,000 deg. F.

Results.—In the hour test it took 60 minutes for the flames to break through the jarrah door, while though at the end of 46 minutes a flame appeared at top of muntin of the karri door, it was not until the fire had been burning for 58 minutes that the top muntin fell out. In the hours' test the fire had been burning for one hour and 24 minutes before it appeared through any part of the jarrah door.

"Transport," of July, 1903, in its report of the test made by the British Fire Prevention Committee the previous day, as to the behaviour of karri hardwood under intense heat, says, "The test formed part of the programme arranged by the committee in connection with the Annual Congress (Fire), and representatives from the Continental fire brigades were present, besides many others. A large brick hut, 22ft. long by 10ft. wide, was arranged with several lengths of karri timber 2in. in thickness. These were placed so as to form a ceiling, and on top of these was a load of bricks weighing about 7 tons. Coal gas was then turned on from a generator in the grounds, and in a very short space of time the interior of the hut was red hot, the temperature at the end of two hours, the time fixed for the test, reaching close upon 2,000 deg. F. Notwithstanding this enormously high temperature, in no place did the fire burn through the wood, and the load of bricks remained undisturbed to the finish. The underpart of the planks—those in actual contact with the fire—were of course, considerably charred; otherwise the wood was unharmed. Everyone present expressed themselves well pleased with the astounding manner in which the timber withstood the test, and none more so than the foreign delegates, to whom the unrivalled strength and fire-resisting properties of karri wood came more or less as a revelation.

Fire Test of Karri Varillas.—A further proof of the fire-resisting character of karri is afforded by the following letter received from Mr. Hugh Wright, Los Mirasoles, Bahia Blanca, 17th April, 1901:—"Last December I had a camp fire pass through half a league of fencing hung with your varillas, and it left them practically uninjured; not one was burnt through or twisted, and those that suffered most were charred less than a centimetre in depth."

From these and other testimonials it is clear that structural works built of karri and jarrah timbers would be practically fireproof; for which reason, also, they are specially suited for underground railway work of every kind—sleepers, platforms, etc. The Underground Electric Railways Company, of London, Limited, have therefore ordered karri sleepers for their Baker Street and Waterloo Railway, specially on account of their fire-resisting qualities.

This is a subject of such importance, in view of the frequent and calamitous fires of recent years, that the company considers the above facts are worthy of the special attention of the public authorities, architects, engineers, and builders.

Railway Sleepers.

The railway sleeper does not readily lend itself to romance ; it is, in fact, one of the most prosaic of the many items which go to make a railway. But, just as the story of the development of the engine from the Puffing Billy of the earliest days to the great locomotive of the British main lines to day, has an interest which, for the expert amounts to fascination, so the humble but essential sleeper carries an appeal to those who have to do with timber, or are called upon to study questions of railway economics. The sleeper, or cross-tie, as the Americans term it, in the form familiar to us, was unknown in the early days of railroading. Many of the British companies used the material handiest to them, or most plentiful in the districts they traversed. Blocks of stone, with a rectangular space cut in the upper surface to receive the chair were in frequent use. Their inelasticity, however, was against them, and a sorely shaken public uttered vehement protest. One English company laid its iron rails on longitudinal baulks of wood, the rail being steadied in the iron chairs by wooden wedges. This system provided the cushioning effect so desirable in railway travelling, and given modern carriage springs, would have produced ideal travelling, but the long lengths of timber proved too expensive to become a permanent rail support. Then the sleeper as used to-day came into existence and, with certain modifications in size and shape, has remained the world medium on which rails are laid.

The breadth of the first sleepers was but six inches. This breadth has been gradually increased until now many railroads use sleepers nine and ten inches in width. Plates or chairs are used on some of these broad sleepers, but on the majority of railways—in America in particular—they are not. In every country except Australia serious efforts have been made to secure economy in the cutting of sleepers. The manner in which they have been cut from trees has been largely determined by the ease and rapidity with which sleepers could be made, and by the knowledge that certain portions of a log were more serviceable for sleeper purposes than others. This practice is still in force in the case of hewn sleepers in the Commonwealth. Abroad, with the introduction of "treated" or preserved sleepers, certain new developments took place. Treated sleepers allow the use of sapwood, of sawn dead timber, and of sawn softwood sleepers. Consequently other forms of sleepers, besides the die-square or rectangular, became possible. Outside the British Empire the form of sleeper which holds first place is the half-crown or flatted top. In contemplating new shapes the first consideration should be to secure at least the same bearing surface on the ballast which the rectangular shape has.

Shape, however, is not the only particular in which the sleeper mostly in use in Britain and Australia, differs from that favoured by other nations, running heavy trains at high speeds. The standard demanded in Australia is probably the most stringent in the world And some of our foreign customers are not satisfied even with it. Every Western Australian sleeper sent to South Africa, for instance, is inspected here and then in South Africa it is re-inspected. Usually at each of these inspections some sleepers are rejected. Now all these rejects would be gladly welcomed in Continental Europe and America.

The French railways are among the most carefully constructed and well kept in the world, but their sleeper specification would severely shock an Australian railway expert. So long as the bottom of the sleeper is of the standard breadth and the thickness right, it is not even insisted on that the sleeper shall be absolutely straight—a maximum deviation of three inches from the middle line being permitted. On this subject M. Mathey, the greatest French authority on timber, in his "Treatise on the Commercial Exploitation of Timber" writes :—"In the matter of sleepers the employment of inferior wood is permissible. They may be made from the upper part of the tree from which the crown springs and from large limbs. It is difficult to understand the excessive quality demanded by the specifications of some companies, or the severity of some of the standards. These impose conditions which are puerile, inapplicable and, indeed, are seldom fulfilled."

In Continental Europe and America, as the result of more than half-a-century's experience, experts have modified their views about sleepers, and their practice goes to show that the Australian standard is altogether too high, and is the result of limited experience, combined with an abundance of first-class timber. The modern tendency is towards an economic sleeper, that is, one whose price and life have fair relationship. The hardwood sleeper costs more than the softwood one, and lasts longer But, if the lower price of the softwood article economically bridges the difference in life of the two, then softwood will be preferred. The creo-pine (creosoted pine) sleeper now holds first place in the estimation of some of the world's greatest railway systems and economically is preferable to all others.

Our best jarrah and karri are too good for sleepers, and the time has come when only second-class timber should be used. Jarrah and karri are among the best hardwoods in the world, and their merits should be made known abroad in some other forms than sleepers and paving-blocks. The foreigner has still to learn about jarrah and karri as structual timber of the highest quality. There are two standard specifications for sleepers cut in Western Australia, one for export sleepers and another for such as are intended for home use. The specifications are as follows :—

No. 1 *Specification*:—It shall be of good, sound, strong timber, free from heart-wood, dry rot, knot holes, to be cut square ; out of winding and straight, except that hewn sleepers may have camber to extent of half an inch.

Sleepers shall not be cut on full quarter and shall be cut with an allowance of a quarter of an inch in width and one-eighth of an inch in thickness to allow for shrinkage, and no further allowances shall be made.

But will allow slight variation in cutting, sound gum veins, gum pockets, up to 6in. x $\frac{3}{8}$in., surface sun shakes, end shakes, up to 6in. few pin holes but not in groups, sap or wane not to exceed 2in., on either face and not to come under rail seat, sound and firm knots up to 2in. in diameter.

Length specified shall be subject to a variation of one inch either way.

No. 2 *Specification—Sleepers* shall be good, sound, strong timber, free from heart-wood, dry-rot, knot-holes, to be cut out of winding and straight, except that hewn sleepers may have camber to the extent of half an inch. Sleepers shall not be cut on the full quarter, and shall be cut with an allowance of a quarter of an inch in width and one-eighth of an inch in thickness to allow for shrinkage, and no further allowance shall be made.

But will allow slight variation in cutting, sound gum veins, gum pockets, up to 6in. x $\frac{3}{8}$in., surface sun shakes, end shakes up to 6in., few pin holes but not in groups, sap or wane not to exceed 2in. on each face, but under the rail seat there must be not less than 7in. of sound timber free from wane ; sound and firm knots up to 2in. in diameter. Lengths specified shall be subject to a variation of 2in. either way.

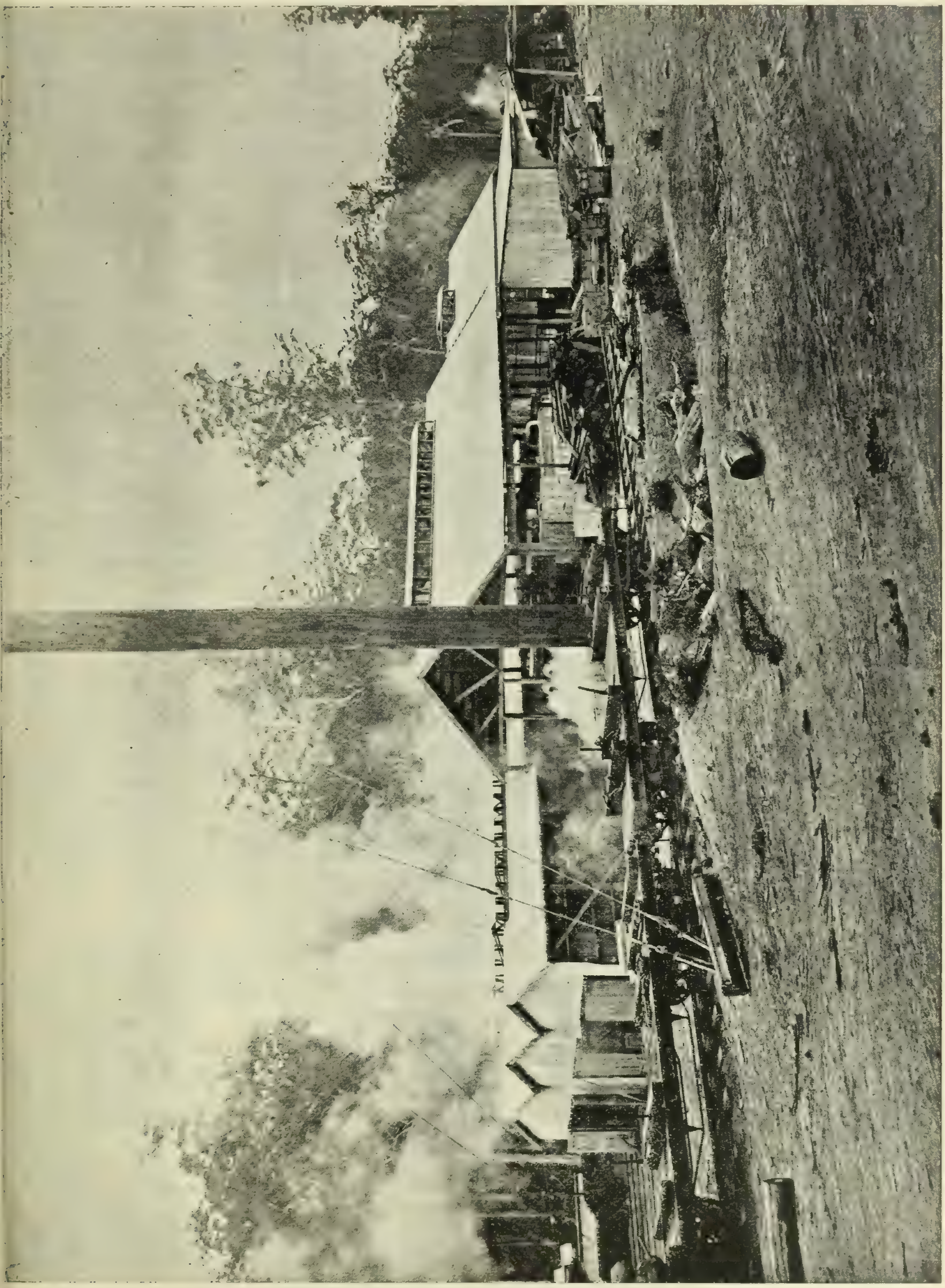
The Preservation of Wood.

The preservation of wood may be defined as the process by which woody fibre is preserved from decay.. The word "decay" is used here in its widest sense, and includes damage done by fungoid growths, by atmospheric agency, or by the attacks of destructive insects. Wood preservation is by no means a modern process, although it is only within this last half-century or so that scientific investigation has been applied to the subject and processes evolved based upon accurate observation. The process, in all probability was practised in the earlier civilisations. It is supposed to have been put into practical effect by the ancient Egyptians, and wooden coffins used by them, estimated to be at the very least 2,000 years old, have been found in a good state of preservation. Wooden dowel pins, probably of preserved tamarisk or chittam wood, were also employed in the stonework of the ancient Egyptian temples, the age of which is undoubtedly over 4,000 years. It is likely that these dowel pins are the oldest species of wood existing in the world, and investigators have expressed the opinion that they have been treated with some preservative agent, probably bitumen.

In modern times wood preservation has assumed the status of a gigantic industry, more particularly in the United States. In the States there are some hundred wood-preserving plants in active operation, representing a capitalisation of over £2,000,000, and turning out products worth about £5,000,000 per annum. These plants use annually over 100 million gallons of creosote and, in addition, about 4,000 gallons of various other preservatives are annually consumed, representing a value of £300,000. In Great Britain wood preserving is also a recognised industry of very considerable extent, and, as in America, many processes are used and many preservative agents, according to the class of wood under treatment and the purposes for which it is to be used.

In Australia wood preserving is also carried on to a very considerable extent, the process here too varying according to the nature of the wood and its purpose. Powellisation is carried on to an increasing degree in Western Australia and in the Eastern States, the largest preserving plant in Western Australia being that operating at the State sawmills at Pemberton. Here a special process is applied to the timber, which mostly takes the form of railway sleepers. The main ingredients in the preservative mixture are sugar and arsenic. The Pemberton process has achieved remarkable success. A large number of the sleepers on the Trans-Australian railway are powellised timber treated in Pemberton and at Manjimup, and these are as good to-day as when they were laid.

No system of preservation of hardwoods is effective against marine borers. Very soft woods may be heavily impregnated with creosote and in this condition are rendered resistant. The most common marine borer in Western Australia is a nausitoria, and to most timbers it speedily



Powellising Plant at Pemberton.

proves so destructive that their usefulness is quickly impaired to an extent that demands replacement. The average diameter of the egg of the nausitoria is less than 1/500th of an inch, and a single worm may lay 100 million in a season. When the egg is hatched, the embryo swims freely in the open water for about a month, after which period it proceeds to attack the exposed surface of wood, countless thousands of them working on a comparatively small surface. The hole by which the teredo enters is minute, but beneath the surface the burrow is soon enlarged to accommodate the rapidly growing body. The burrow extends usually in a longitudinal direction and follows a very irregular, tangled course.

The borer possesses two distinct canals, one by the aid of which it assimilates the microscopic organisms in the sea and which are sucked in by means of a tube protruding through the minute hole on the outside of the timber, and the other through which it evacuates the borings which it cuts out in the process of making its home, for this is all that the tunnels in the wood are used for. From this it is clear that the poisoning of the borer by disinfectants injected into the timber is of little use. With very soft woods, which can be heavily impregnated with creosote, the effect is different. It is then not so much a question of poisoning the borer as clogging up the wood with creosote and so preventing the satisfactory working of the worm's boring apparatus.

THE PRESERVATION OF TIMBER IN STRUCTURES.

The outstanding disadvantages under which timber labours, as a structural material, are its liability to decay and to destruction by fire. In both of these directions, proper treatment is able to do a great deal, and improvements in preservative methods, particularly against decay, have been very striking.

Decay is caused by living organisms of the class known as fungi. These gain entrance to the wood when the bark is removed or injured in any way. The spores of fungi are carried by the wind or other agencies, and if they lodge on timber they soon begin to grow. They need for their life processes air, moisture, food, and sufficient warmth. Under favourable circumstances they send out their fine tendrils, which gradually find their way through the wood, penetrating the cell walls of the fibres. They dissolve the wood substance and use it for food, and in time the timber falls to powder under the attack.

Microscopic examination of decaying timber shows clearly the method of action. The fine filaments of the fungi can be seen penetrating the cells. The life history of many of the wood-destroying fungi has been studied and this has enabled methods to be devised for combating the evil. Moisture is essential to all fungi and therefore properly seasoned timber is not liable to decay if it is protected from wet. This is a point of the greatest importance in factory design. Timber placed in a position where it is kept moist is very liable to attack by fungi. If green timber is used there is the same danger. Hence in factory construction it is essential to use dry timber and protect it from wet. To ensure this, proper ventilation is essential so that moisture can evaporate from the timber. In many cases where decay is detected by means of the growth of fungus on the outside, it is possible to arrest decay by proper ventilation and drying. Many of the wood-destroying fungi are sensitive to moderate rises of temperature, and their action can be arrested by raising the temperature in a building to above the critical temperature, so long as this is not high enough to injure the timber. This method is largely used. The possibility of this treatment depends upon the nature of the particular fungus doing the damage.

Another method employed in preserving timber in buildings is the use of preservative fluids. In some positions, where the appearance is of no importance, the timber is creosoted. This is effective but has many disadvantages. The process is expensive and the timber is coloured and has a disagreeable smell. To obviate this, solutions of mercuric chloride or soluble fluorides and other toxic substances are painted on the timber. In such cases the surface is rendered immune from attack so long as the timber is protected from rain. If it be exposed to the atmosphere such treatment is quite ineffective, as the preservative substances are soon washed out.

A great deal of work has been done in America on preservative treatments of timber for constructional purposes, and results of such value have been obtained that an association of fire insurance companies has published pamphlets setting out the cause and methods of prevention of decay. Methods of design of factories have been worked out to ensure the best conditions for long life in the timber.

Decay is of great importance to insurance companies because it renders the timber so much more inflammable. In factories where water is used in large quantities, such as paper mills, it is not possible to keep the timber dry, and then creosoting or similar treatment is essential. The extent of the damage done is not generally realised, but it is enormous and costs the community immense sums of money. In the event of decay showing, it is necessary first to find the nature of the fungus. If it is fruiting the identification is easy, but in many cases it is difficult or impossible to identify the young growth. The chief use in identification is to determine the best method for treatment. If the particular fungus is sensitive to heat, it often happens that closing the building and raising the temperature by fires is quite enough to kill the fungus off. Some fungi, however, can stand temperatures nearly up to that of boiling water. In such cases this treatment is impracticable.

It is not the position of the fungus growing on the outside of the timber that is doing the harm. When this is visible to the eye the damage is often far gone, and the whole of the timber structure may be permeated with filaments. A fungus has two stages in its life history. The first is the growth of the fine cotton-like filaments which penetrate the timber and do the damage. The second is the fruiting stage indicated by the appearance of mushroom-like growths or surface incrustations. This produces the fruit and the fruit bodies produce the spores, which are carried about and spread infection whenever they fall on moist timber. The spores are not the only cause of infection, however, for infected timber on which the fungi have not fruited can spread the disease to clean timber. It is essential, if any curative treatment is to be adopted, that the decay should be detected in its early stages. If it has progressed far there is nothing to do but cut out and replace all faulty timber with clean material. Frequently the fungi are introduced with apparently sound timber. Lumber is often stacked in yards under conditions very favourable to the spread of the disease. Dirty and decaying timber are allowed to lie about the yard. The stacks are built on the ground, which is often infested with fungi spores. Old strips, instead of being burned, are used for fresh stacks of timber and infect them. If reasonable care is taken by the lumber merchant, these sources of infection can be avoided. The first essential is a clean yard, and all refuse should be burned. Yards should not be established on wet ground, nor should they ever be filled in with sawdust, bark, or such refuse. It is a great help if uninfected timber is used in the construction, but the spores of fungi are hard to kill and are easily carried about. Consequently it is still more essential to erect factories under such conditions that the fungi are not encouraged. The main points are to keep the timber dry and as well ventilated as possible.

The Timber Diseases Branch of the Madison Forest Products Laboratory has done a great deal of valuable work in preventing the spread of decay. Its officers are in close touch with architects and factory engineers and are often engaged in tackling a decay problem on the spot. It is remarkable how successful a few simple precautions carried out under scientific guidance often prove. The prevention of decay in buildings is only one of the avenues of research of this department. The question of the preservative treatment of railway ties, mine timbers, farm timbers, wood blocks, and numerous other forms of lumber has been closely studied. We here, however, deal very briefly with the one aspect of preservation. While jarrah is remarkably immune to the attacks of fungi, karri is as easily attacked as any soft wood and as great care should be taken in looking after this timber. Block stacking of karri, viz., the stacking of this timber in solid piles without strips between each layer is a fruitful source of dry rot, and care should be taken to insert strips ½in. thick between every layer, so that there may be free circulation of air around the wood.

Forest Entomology in Western Australia.

The forest insect problem in Western Australia is a very serious one from many aspects, not the least being the fact that nothing has been done in this matter from the inception of the Colony, nor is the trouble confined to the growing timber, for insects cause tremendous damage and loss in many finished products, such as buildings, furniture, vehicles, etc., etc. In fact, no timber is safe from insects unless especially treated to repel their attacks, white ants (*termites*) being the worst offenders in this respect.

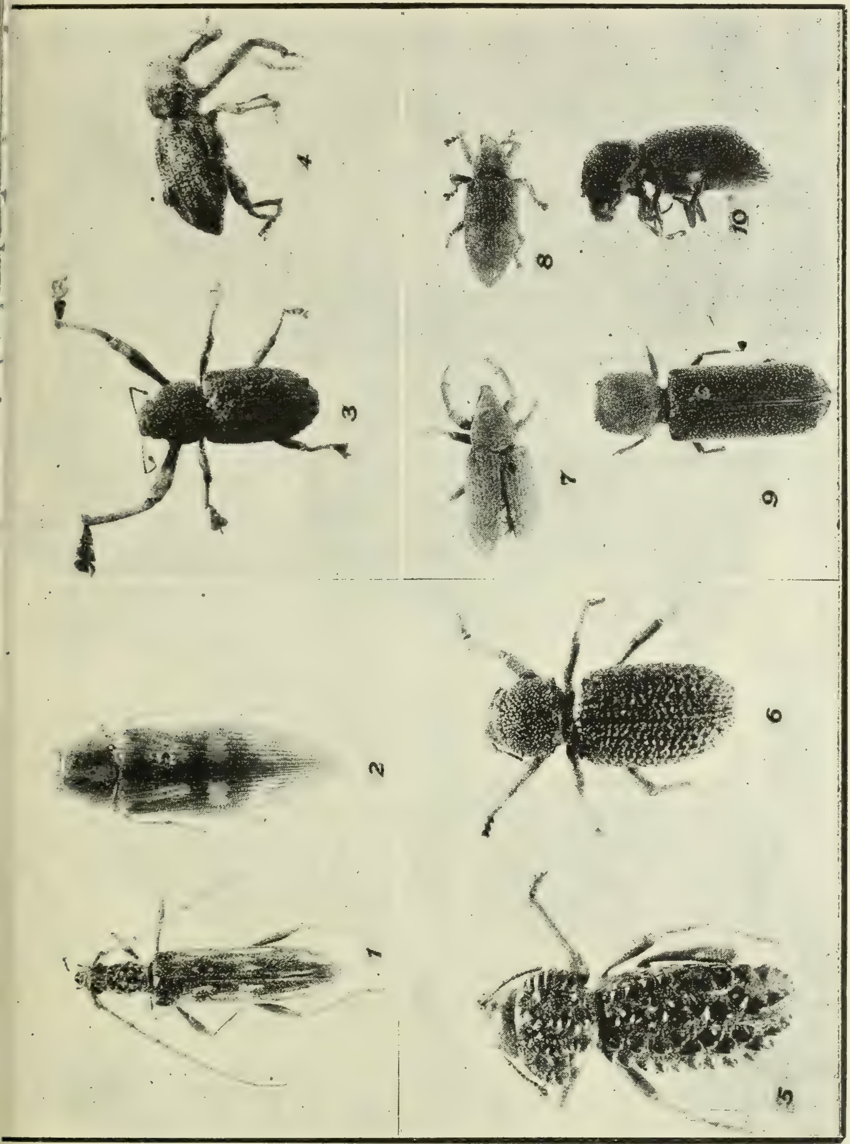
Insects not only cause the death of large numbers of young and old trees but are responsible for the great reduction in the value of the sawn product. Trees are attacked in various ways and by many different groups of insects. Some prefer the leaves and young shoots, some the bark, others the sap, and still others burrow right into, and live for many years in the heartwood of the tree, while a few prefer the roots and others the seeds, so that there is really no part of a tree that is free from attack. From the time the seed is dropped and commences to grow until the tree is ready for falling and cutting up, it has one continual struggle against insect and fungus pests. Most " dry rots " and " gum veins " in standing timber can be traced to insect origins.

Whilst some insects confine their attention to one species of tree, others are not so particular, but attack several species, and to enumerate the various pests of the forests would require a huge volume. But it must not be supposed that all insects are injurious, for a large number of those frequently seen are beneficial and help to keep in check the many destructive insects, for most, if not all, of our pests are preyed upon by various other insects. Birds and many small marsupials also play a very important part in checking the pests of the forests. Many wasps and flies deposit their eggs in or upon the larvae or pupae of various insect pests, the eggs hatching shortly afterwards, the little larva devours its host gradually, leaving the vital parts until it is ready to pupate, which it usually does within the remains of its host. Some wasps capture and stock their nests with caterpillars as food for the young wasps when they hatch from the eggs, while a large number of beetles hunt for and devour all the insects they can find. Many bugs also are highly predaceous, catching and sucking the life blood from their victims. The larvae of some moths (*Tlalpochares*) are very useful in destroying scale insects. Beetles are no doubt the greatest offenders in our forests, and of these the most numerous are the weevils (*Curculionidae*), jewel beetles (*Buprestidae*), and long horned beetles (*Longicornes*), but some of the smaller families of borers are very destructive, although not so numerous, the most notable being the *Scolytidae*. This group contains some of the most dreaded of all forest insects, and in some parts of the world large areas have been laid bare by the activity of the larvae which are universally known as pin hole borers. Although a small insect (being less than $\frac{1}{4}$th of an inch in length), our pin hole or jarrah borer is well known from the large amount of damage it does to growing timber. The eggs are probably laid singly in crevices in old wounds, such as old bench marks or other injuries which have exposed the dead timber, the larvae usually boring straight through and pushing the borings out behind as it goes in, and soon a pile of borings and numerous threads sticking out can be seen on the tree. The damage caused by this small beetle to the timber cannot be estimated at present. The damage is not confined to jarrah, as several other trees are attacked in the same manner.

The *Bostrychidae*, or auger beetles, are well represented, one of the largest species (*Bostrychopsis jesuita*) being fairly common, and sometimes attacks cultivated trees in the orchards. Several introduced species are sometimes met with, particularly *Phizopertha dominica*, well known as a wheat pest ; one specimen, *Xylothrips religiosa*, a beetle previously known only from the North of Queensland, is not uncommon about Perth.

Weevils can readily be distinguished from other beetles by the head, which is supplied with a snout, and are generally known as " Elephant beetles." Their mode of attack is as varied as the group itself. Some attack only dying or dead trees, while others take the living plants. The larvae burrow or tunnel in the roots, trunk, twigs, and the perfect beetles eat the foliage, buds, or bark. A weevil with a wide distribution over Australia and with very destructive powers is *Orthorrhinus cylindrirostris*. This beetle does not confine itself to the bush, but attacks also orchard and garden plants and trees. The larvae burrow through the centre of the limbs and pupate there, causing the death of the limb or tree; the perfect beetle eats the buds and bark of various trees.

The jewel beetles are well known from their brilliant colouring, and are commonly met with during the summer months. They range in size from an eighth of an inch to three inches in length. The female lays her eggs in crevices in the bark and the larvae feed on the sap wood until strong enough to bore through the hardwood, through which some are reputed to tunnel for many years before finally pupating. These beetles cause the death of many trees, young and old, in the forests and in the gardens, where the activity of one group (*Diadoxus*) can often be seen by the many dead trees in cypress hedges, these trees having been sap rung by the larvae of *Diadoxus scalaris* and *Diadoxus erythrurus*. The *Longicornes* can readily be distinguished from the other beetles by their long horns or feelers (*Antennae*) and amongst them are to be found some of our largest beetles (one North Queensland specimen, *Batocera Wallacei*, measuring up to 17 inches from tip to tip of the *antennae*). The larvae or grubs of these beetles are generally referred to as bardies, but the bardies eaten by the natives and some bushmen



(1) *Coptocercus undulata* (Hope), Eucalypt borer.
(2) *Diadoxus scalaris* (C. & G.), Cypress pine borer.
(3, 4) *Orthorrhinus cylindrirostris* (Fabr.), General borer, very destructive.
(5) *Macramycterus Schonherri* (Hope), Root borer.
(6) *Molochtus gagates* (Pasc.), Root borer.
(7, 8) *Strongylorrhinus ochraceus* (Schl.), Gall formers on eucalypts.
(9, 10) *Bostrychosis jesuita* (Fabr.), Universal borers, very destructive.

are the larvae of one of the largest wood-boring moths. This group contains many serious pests of the forest and frequently renders trees useless for milling purposes. One specimen, *Coptocercus undulata*, is a well known pest in jarrah, tuart, and marri, its burrow, which is under ¼ of an inch in diameter, frequently extending a considerable distance through the tree. This is one of the few beetles which makes a squeaking sound when captured. Two serious pests in this group are *Bethelium cleroides* and *Omophaena taeniata*; both are small, not more than half an inch in length, but destroy a large number of young trees and branches on older trees. The larvae burrow through the sap wood. Another beetle of this group, *Symphyletes lateralis*, has a peculiar habit of ringbarking the young terminal shoots of various trees and plants.

Amongst the moths several boring pests are to be found. These belong mostly to the families *Hepialidae*, *Cossidae*, and *Zeuzeridae*. The female lays her eggs upon the bark, on which the larvae feed until strong enough to tunnel into the hardwood, in which some of them remain for several years before they pupate. The moth emerges during the summer and the empty pupal case is frequently seen projecting from the hole in the tree or from the ground around the foot of the tree. These large and showy moths can often be taken clinging to the bark of trees or on fences, and often fly to lights at night. Another group of moths which cause a lot of damage are the *Cryptophaginae*, whose larvae tunnel down into the terminal branches and shoots of young trees. The entrance is always covered with a silken bag or net, which is generally full of bits of leaves, bark, and droppings from the larvae. They come out at night to feed and drag the leaves into their burrow to feed on at their leisure. There are several species of this group and they attack various forest trees. Galls on our forest trees are caused by various groups of insects, and one large and curious gall which aborts the branches of York and other gums is the work of the larvae of a weevil. *Strongylorrhinus ochraceus* is another pest through which large numbers of trees are destroyed, and other galls are equally destructive.

Scales and other sap-sucking insects do considerable injury by impoverishing and frequently causing the death of young plants.

Many galls and scales could, no doubt, be made use of commercially in the manufacture of inks, stains, and varnishes, and material is being collected for investigation into the possibilities in that direction.

Pine Planting.

The function of forestry in any country is not and ought not to be confined to the care and protection of indigenous forest growths; it interests itself also in the provision, so far as circumstances will permit, of such exotic trees as yield classes of timber that find a market in the community. All the timbers of Western Australia, for example, are hard, but there exists a large demand for woods of a softer nature, and, as these woods do not grow locally, they have to be imported. According to the annual report of the Forests Department for the year ending 30th June, 1919, the value of foreign-grown timbers and articles made of foreign-grown timbers imported during the year 1918 was over £60,000. In normal times, when shipping facilities were plentiful, the annual value of such imported timbers before the war was £143,453, and when tonnage in quantity is again to be had this last amount will certainly be equalled and probably exceeded. A progressive forest policy seeks to prevent the paying away of such large sums for timber from abroad by growing the required timbers at home. This policy is an eminently wise one, for not only is the money kept in the country, but the growing of new kinds of timber provides employment in the planting of the new varieties, in their care during growth, and in reaping and converting them into marketable merchandise when mature.

Softwoods—pine—fill many essential purposes in industry. For instance their comparative lightness, as compared with hardwood, recommends them as containers for many kinds of goods. In spite of the fact that native timber can meet every detail in building construction and fulfil most of them better than foreign woods, there continues to exist a large demand for the imported article. This demand, despite the quality of the native wood, is likely to continue, and sound economics indicate that the best way to deal with it is to supply it from local products.

The fruit industry is another instance in point. It is one of Western Australia's growing industries. The lightness of softwoods and their white colour in this case recommends them, and here again is an argument for meeting the local demand by a local supply. There is nothing in local conditions of soil or climate inimical to the planting of pines so long as suitable varieties are selected. There are pines which demand a good soil and a heavy rainfall if the trees are to reach perfection. There are other varieties which thrive in a poorer class of soil and with a lesser rainfall, and there are again still other kinds which do well on what can be called really poor soil, and with a comparatively low annual rainfall.

The whole of this softwood, whether for structural work or case-making, can be grown locally, and the area required for this purpose will be comparatively small. South Australia furnishes a valuable object lesson in this respect. That State is less bountifully provided with indigenous timber than any other in the Commonwealth, but the local Forestry Department for a generation has been working hard to repair the neglect of Nature, and, so far as the softwoods are concerned, has succeeded admirably. Pine plantations of mature timber are now being reaped there. A few months ago timber was being sawn up in South Australia that had been planted by Mr. Ednie Brown, at one time Conservator of Forests there, and subsequently holding the same office in this State, and the net profit, after deducting all charges, including compound interest, on the cost of formation, amounted to more than £100 per acre.

The South Australian plantations are very valuable, but they would have been of more value had those at the head of affairs at the time the areas were planted given more attention to the recommendation of the skilled forester in charge. Large areas were required to be planted, but, as the funds made available were quite inadequate for properly planting such big areas, the trees had to be widely spaced, and the effect of this error is being felt now. Pines when widely spaced are apt to grow knotty and a bad shape, and being short and conical, sawing becomes wasteful. Planted closely as they ought to be, the trees grow taller, have longer barrels, and consequently, fewer knots. From such trees scantlings and boards of value for many purposes may be obtained. With close planting, at 15 years of age the thinnings would yield valuable case wood, and these thinnings should, under ordinary circumstances, pay the whole cost of formation of the plantation, leaving trees that at maturity would produce first-class timber.

In Western Australia steps are now being taken for the plantation of suitable varieties of pines in various localities. On the Mundaring catchment area it is intended to put in an experimental plantation of 100 acres. A larger work of the kind, which it is intended shall be one of the State's great permanent pine plantations of the future, will be situated to the Northward of Perth on a large area between the Midland line and the coast. This area has already been surveyed. It is proposed to plant something like one square mile per annum. The Southern boundary of this plantation will be within 10 miles of Perth. All over Europe it has been found to be of distinct advantage, indeed essential, to have pine plantations in fairly close proximity to cities. The reason for this is firstly economic, and secondly social. When the time comes for the timber to be thinned, the large population close at hand provides at once a ready market for these thinnings, not only for firewood but for numberless purposes and manufactures. If the plantations were far removed from the centres of population, it would not pay to convey such thinnings for long distances to the market.

Pinus insignis at Hamel, 16 years old.
Planted too wide and so only fit for case wood.

The social side of the forest has also an importance of its own. These pine forests in due time will become holiday recreation reserves for the people of the city. Examples of forests close to cities and used very largely for recreation purposes are to be found all over Europe, the woods quite close to Paris and to Brussels being very fine illustrations in point.

Of the many varieties of pine the Monterey Pine (*Pinus insignus*) is eminently suitable for districts having not less than a 25in. rainfall and soil of good quality. For sandy soil in the same rainfall the *Pinus pinaster*, Cluster Pine, is indicated. It will do best on poor, silicious sandy soils, and, judging by experimental plantings carried out at Hamel and Ludlow, it thrives luxuriantly in the coastal sands. The value of this tree in Europe is well known, for it yields, besides a fair second-class softwood, a large percentage of the turpentine of France. Thinnings of this species already find a good market in Perth for box-making.

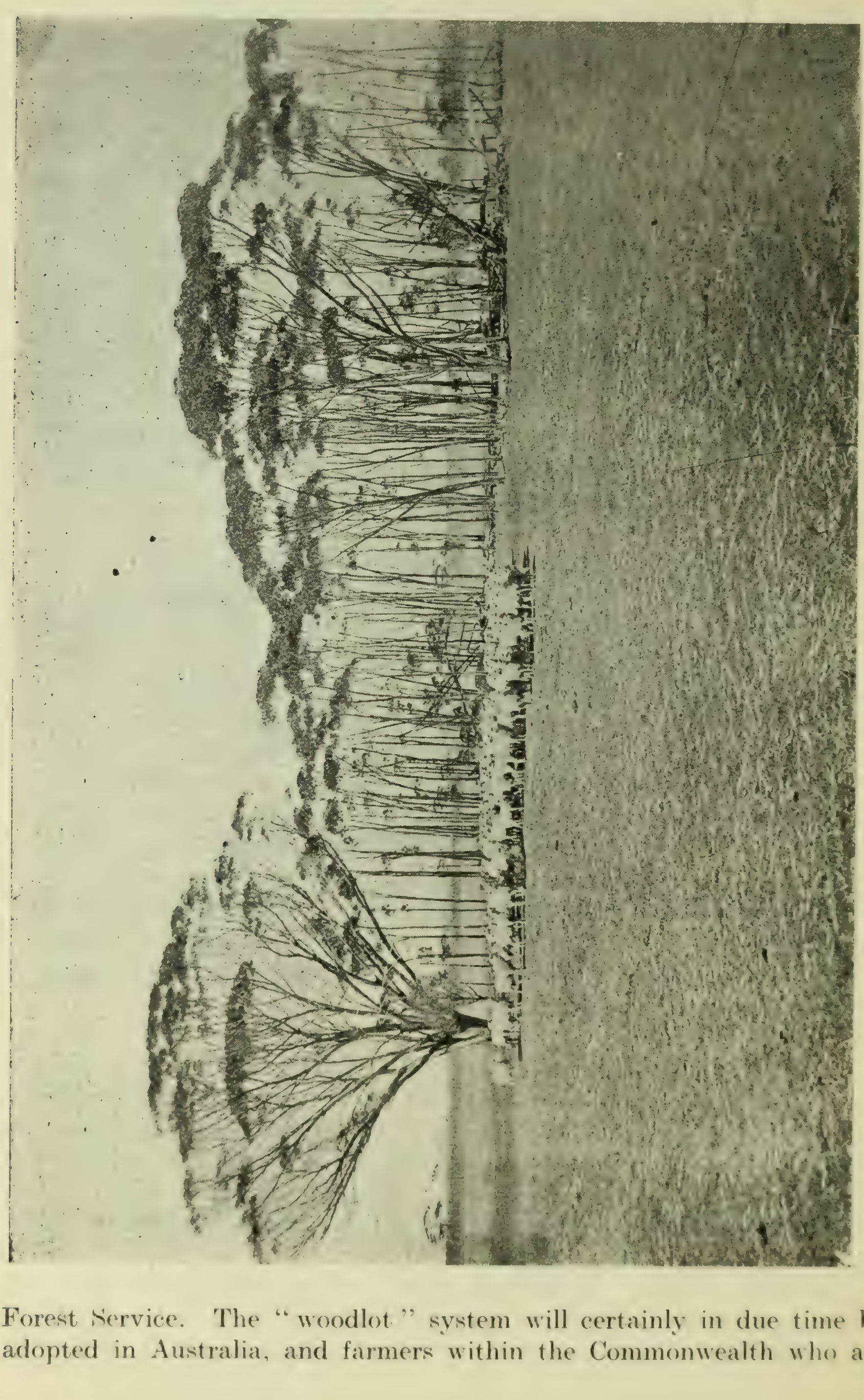
The Farmer and Timber.

When a prospective farmer takes up land in any of the agricultural areas of the States, he immediately sets about getting rid of as much of the standing timber as he possibly can. Year after year he increases his acreage under crops until all the land that is suitable for his purpose is occupied. In the earlier days of settlement it never occurred to the pioneer farmers that a time would ever arrive when there would be a shortage of timber in the neighbourhood. In the older settled districts of Western Australia so complete has been the denudation of trees that quite a number of farmers have to buy every stick that they use on the farm, and some are even hard pressed for firewood. What has happened in Western Australia is also taking place in the Eastern States, and already farmers in the latter are seriously contemplating the growing of timber not only for use upon their farms, but as a crop to be turned in due time into hard cash.

In this matter Australia is repeating the experience which has attended settlement by people of British origin in other parts of the world. America may be instanced as a case in point. In the Eastern States of America the destruction of timber has been so complete that sawmills and timber dealers in the district make specialities of what they call "farmers' requirements." The farmer there, having no timber on his land with which to do a bit of fence repairing or well sinking or shed building, has to purchase all that he needs from dealers. The Department of Agriculture in Washington for half a century and more has been giving earnest attention to the matter, with the result that over nearly the whole of the timber States of the Union every farmer has what is known as his "woodlot." This woodlot is either a patch of timber growing on land that cannot profitably be utilised for the usual crops, or it is an area which the farmer has planted with seedling trees with the object of growing them for profit.

The farmer's woodlot in the United States has become an institution among the agricultural community, and the crop of timber it yields is annually reaped as regularly as the other crops. The advice and assistance of the United States Forest Service is at the disposal of every farmer. If he possesses a strip of old timber country, the Forest Service will teach him how to cultivate it so that its yield of marketable timber may be increased. He will be told what trees to cut down and what to preserve for the future. In bare patches recommendations will be made as to the kind of tree best suited for the soil and rainfall. In short, the farmer possesses in his woodlot a miniature cultivated forest.

If, on the other hand, his woodlot has been planted by himself, it is safe to say that the trees have been selected under the advice of the Forest Service. The "woodlot" system will certainly in due time be adopted in Australia, and farmers within the Commonwealth who are



Trees providing shade for stock.

so improvident as not to add to their income by growing timber will be few and far between.

Timber on a farm, however, serves other purposes than adding to the farmer's sources of income. The planting may be so arranged that the trees form wind-breaks or act as shade for stock. The kind of tree to be planted in Western Australia depends, of course, upon the soil and rainfall. Pines of many varieties are excellent in the farmer's woodlot. Their "rotation," that is, their period of growing to maturity, is very much shorter than that of hardwoods. A young farmer planting eucalypts on his land is extremely unlikely to see them attain such a size as to justify giving them the name of merchantable trees, but when pines are introduced the young farmer may expect to see his crop arrive at maturity, and he may reasonably hope to go on for years reaping the reward of his forethought. Many farms in Western Australia to-day, in the districts more recently settled, have considerable wealth of timber on them. The varieties, of course, will depend a good deal on the district, but whatever varieties there may be they are well worth preservation.

Our principal commercial timbers, karri and jarrah, are being cut down at such a rate that the present volume of home and export trade cannot for long be continued. There will assuredly arrive a period when jarrah and karri will be comparatively scarce woods until the new crop has grown. During that period less used timbers will acquire a new value and a new significance. Among these timbers are yate, blackbutt, morrell, York gum, salmon gum, raspberry jam, banksia, sheaoak, and others. When jarrah and karri become scarce, the trees just named will certainly acquire an enhanced value. The farmer will be wise, therefore, to treat the timber on his land with great circumspection, and on no account to waste it recklessly. It is not, however, intended that farmers should grow timber on land suitable for the use of agricultural crops, but only on such portions of their holdings as are not adapted for these crops, and upon which timber is the most profitable crop which can possibly be grown. These are the areas which the farmer should cultivate and conserve against the time when timber will be scarce and dear.

Forests and Sand Drift.

The reclamation of sand wastes by tree planting is by no means a present day invention. In ancient times the value of trees, shrubs, and grasses in arresting the progress of drifting sands and transforming valueless country into arable land was known and practised. In more modern times many notable instances of what can be done by well conceived efforts in this direction may be named. In Russia, for example, the loss of valuable land through sand drift encroachment had attracted so much attention, and the lesson it taught was so clearly understood, that in 1888 a law dealing with the subject was brought into operation. Under this law forests were declared to be "preserved forests" when they served as preventives against the formation of barrens and shifting sands, and the encroachment of dunes along sea-shores, or the banks of navigable rivers, canals, and artificial reservoirs, or when they protected from sand drifts towns, villages, and agricultural areas. In the matter of what can be done in the way of reclaiming land that has become useless and valueless through being covered by shifting sands, France affords the classic example. How 2,500,000 acres of barren land, of practically no value, was changed in the space of 70 years into a huge forest, having a value ranging from £2 an acre for recently cut-over land to £100 an acre for land timbered with trees of 50 year's growth, and how, during the process, drifting sands which engulfed villages and destroyed large areas of cultivable land were stayed, the population increased from 70,000 to 300,000, and the department converted from being one of the poorest in all France to one of the richest and most prosperous, is the story told in a report, "The Maritime Pine in the Landes of Gascony," by Capt. L. C. Tilt, of the Canadian Forestry Corps, commanded by Brig. Gen. J. B. White, who served many months in France.

The report provides a striking object lesson for Australia and Australians. In this country, where so much of our natural wealth originates in the forests, considerable tracts of land around our coasts, which are either already covered by drift sands or are in danger of encroachment, ought, in the public interest, to be reclaimed or made safe by planting with suitable trees, shrubs, and grasses.

The following extract from Capt. Tilt's report is printed in the belief that it will prove of interest as well as of practical value to those concerned with the conservation and development of Australia's forest heritage :—

The home of the Maritime Pine, sometimes called the Bordeaux Pine, is on the sand plains or lands of Gascony, on the Atlantic coast, in the S.W. part of

France. The Maritime Pine is also found in small quantities along the coast from Bordeaux to Boulogne and in the Central part of France and along the coast of the Mediterranean.

The area covered by this great forest in Gascony is as follows for each of the three departments:—

Landes	516,608	hectares
Gironde	461,915	,,
Lot-et-Garrone	100,000	,,
Total	1,078,523	,,

(1 hectare equals 2·47 acres.)

In the Department of Landes 55 per cent. of the total area is timbered, the highest for any Department in France, while in the Gironde 46 per cent. is in forest.

This area forms a triangle with apex to the north, bordered on the east by the Gironde and Garonne Rivers, on the west by the Atlantic Coast, and on the south by the Adour River from Dak to Bayonne.

It may be said with perfect justification that there is no State in the Commonwealth which has not, on its coast, or in some inland district or districts, areas of land where the sand is slowly but surely eating its way into and threatening ruin to country capable of being made use of by man. Western Australia has its shifting sands, but the danger has been recognised and remedies are being applied.

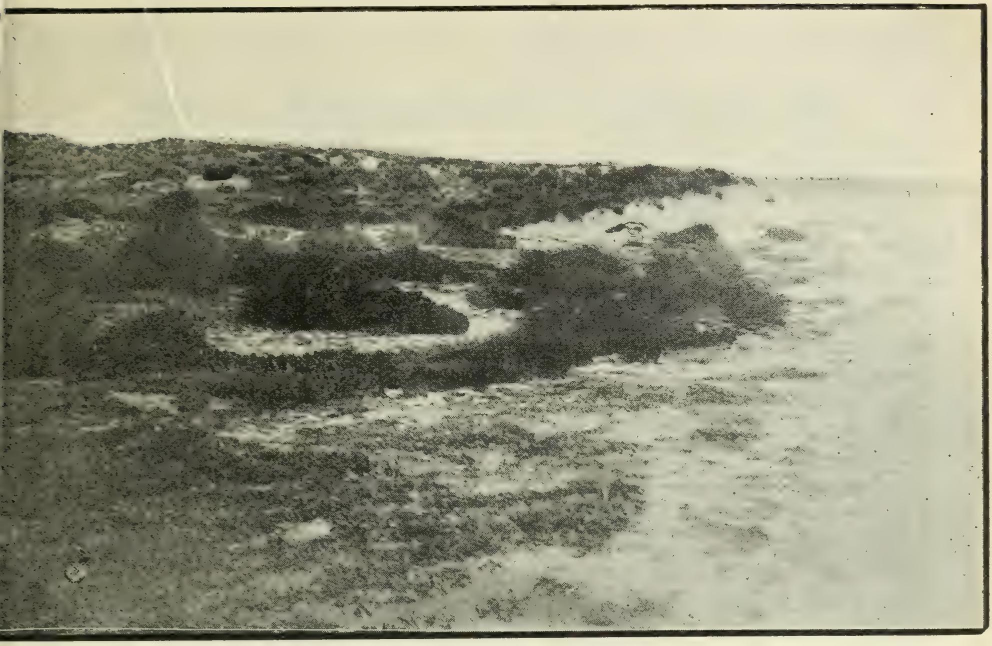
Near Karridale is to be found the famous Barranup Sand Patch, where, during the short time that the M. C. Davies mills were running, the sand moved eastward so rapidly as to make it necessary to build three roads one after the other. It was finally stopped through the energetic steps taken by the milling company planting marram grass. To-day there is an expanse of about two miles deep along the coast of sand dunes. Here and there are to be seen the tops of karri trees protruding from sand hills 150 to 200 feet high. There are many other localities round the coast where drift sands prevail, and almost everywhere drift sand conditions are possible if the vegetation now holding the dunes is destroyed.

At the mouth of the Warren, and between that river and the Gardiner River, is a large sand patch. Here, history relates that a farmer got stuck with his wagon. He took out his team and drove them home, intending to return later to get his wagon out. He put it off till too late, for when he got back his wagon was no longer to be found. It had been covered by a hill of sand.

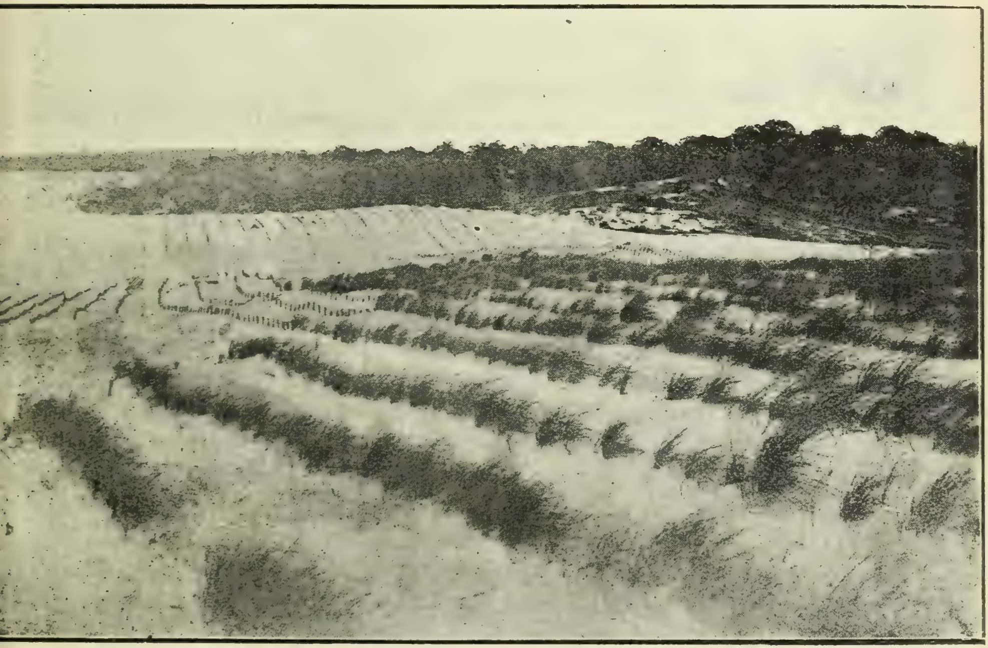
Near Denmark, along the Kent road, is a sand drift which has entirely covered a patch of immense karri trees. Around Albany the same conditions occur, and so on round the coast instances of drift sands can be multiplied. With the growth of the population of the State and the pushing forward of agriculture round the coastal belt, it will be necessary to take these sand drifts in hand, fix them and reforest them with pines.

Inland sand drift conditions also occur throughout Australia. The best known examples are probably those to be found in the interior of South Australia. There the natural vegetation was destroyed by man and his flocks and by the rabbit, with the result that what was once fair grazing country is now shifting sand. Inland in Western Australia we find sand plains intersected with agricultural land, and these conditions offer dangerous possibilities wherever the climate is such that farming may be done. The farmer, too, often clears all the timber in sight, irrespective of whether the land is suitable for wheat-growing and other agricultural development or not, with the result that not only does he expose his farm lands to the desiccating winds which now blow unchecked by tree growth, but also he exposes these lands to the invasion of the sand from neighbouring sand plains. A journey through the Eastern Wheat Belt will convince any impartial observer of the danger that is threatening the country through the thoughtless clearing of the land of all timber. The lesson which Algeria and Mesopotamia teach has not been learnt in Western Australia. Those two countries once contained large areas of very fertile agricultural land, but, owing to the over-destruction of the natural covering, to-day the area of agricultural land has been reduced to an almost negligible quantity, and the once fertile lands are covered with sand. In Algeria resort is being had to the eucalyptus trees of Australia to stem the invasion of the sand.

At Cottesloe, a residential suburb of Perth on the coast, the sand-drift question for long has given much anxiety to the local authorities. With praiseworthy energy the Town Council set to work to plant marram grass extensively. The grass has taken root very satisfactorily, and it would seem to be a question of a short while when the sand-drift menace shall have become a thing of the past. The next step will be to establish pines or other trees on the fixed sands, for marram grass only thrives while the sand is blowing, and permanent vegetation must be substituted. The illustrations on another page vividly demonstrate what has been done at Cottesloe to overcome the drift-sand menace by the planting of marram grass.



Marram Grass at Cottesloe.



Marram Grass at Cottesloe.

Mundaring Catchment Area.

The direct advantages of forests to a nation are fairly well recognised by the vast majority of people, but their indirect value is not so widely recognised. Direct benefit arising from timbered areas can scarcely fail to be appreciated, for it is visible to all in the employment timber getting and utilising affords, and in industrial and mercantile operations following the activities in the bush. But the indirect advantages do not so frequently come under the notice of the citizens. Indeed, some of the most important are of a quality which is understood and appreciated only by those who have devoted long and patient study to the question. But the only one of the indirect benefits of forested regions that it is necessary here to mention has reference to climate. It is agreed by scientific men all over the world who have given attention to the matter, that trees in masses of greater or lesser extent exert a very marked influence on temperature humidity and precipitation. In France the evidence collected on the point is quite conclusive, and leaves no room for doubt, and historians mention many instances where the destruction of forests has totally altered the climatic conditions, by converting what at one time were highly cultivated prosperous regions into something akin to deserts. Summing up the results of his inquiries, a British writer of a generation ago said :—" From a consideration of these facts, it appears evident that, within certain limits of course, by the distribution of plantations of such extent as may be suited to the particular circumstances of each case, it may be in the power of man to modify certain local climatic conditions, so as best to suit the various kinds of crops he cultivates in different localities."

But there is another aspect of forest value to a country over and beyond those which relate to precipitation, the flow of rivers and the feeding of springs. There is the equally important question of the effect of trees upon supply and quality of water delivered by catchment areas into reservoirs. A recent British writer, referring to this phase of the general question, says :—" The catchment areas of the water supplies of our great cities and towns provide another instance of our ignorance of the utility of woods. Not only do the trees maintain a larger supply of water in the reservoir, a point perhaps of less importance in our climate (though one of the chief in a hot dry climate), but they exert an incalculable influence on the purity of the water. We have been slow, extraordinarily slow, in realising the great importance of planting up our catchment areas." But those who are responsible for the carrying out of water supply schemes, however efficient they may be as engineers, or however well-meaning their intentions, have not always been sufficiently instructed in that branch of forest economics which concerns itself with the relationship between forest cover and water conservation. The result has been that now and again grievous mischief has unwittingly been done, and large expenditure has had to be incurred in repairing the evil effect of mistaken judgment. The Mundaring Weir catchment area is a case in point. The Weir catchment area has an expanse of 364,000 acres, all of it fairly well timbered, the principal trees represented being jarrah, marri, and banksia. When the Weir was approaching completion, in 1903, and the vast capacity of the reservoir—4,600,000,000 of gallons—was fully understood, there arose in some quarters apprehension that the dam might not be filled, because—it is alleged—a considerable proportion of the rainfall upon the area would be absorbed by the existing live forest cover. The experience of a good number of years has proved how groundless was the fear, but, nevertheless, those in authority were so much impressed by it that they gave orders to ringbark a portion of the area, and over 20,000 acres were rung accordingly. The end which the instigators of this thoughtless and mistaken act had in view was to increase the "run-off" of water from the wooded slopes. They achieved their object beyond a doubt. The ringbarking was a grave error of judgment and evinced a singular lack of appreciation of the facts. The average annual rainfall in the Mundaring Area is over 40 inches, an amount which, after making generous allowances for soakage and the requirements of vegetation, is amply sufficient to more than fill the reservoir, and the huge annual overflow at the weir constitutes a proof that cannot be controverted. Had no ringing been done, the reservoir would have been filled, but living trees on the rung section would have had the effect of holding up a portion of the rainfall, with the result that the water would have been given off gradually, the overflow from the weir would have been less copious, and the average level of the water in the reservoir would have been higher. In Western Australia, where a good deal of land is salt-impregnated, if a catchment area is established on such land and the trees on it rung, the inevitable result is that the salt tends to come to the surface and the water running off becomes more or less saline. The Mundaring area was at one time thickly covered by a fine stand of timber, as the big stumps left by early exploiters testify, but regrowth has to a very large extent been destroyed by repeated fires. The whole area, in fact, is in urgent need of the forester's craft. The soil and climatic conditions are eminently favourable for the growth of fine timber, but systematic sylvicultural operations are essential, and these operations must include measures for the control, if not the entire prevention, of fire.

With the co-operation of the Water Supply Department, the Forests Department has undertaken the good work of restoring the forests to their former condition, and the work of regeneration, the planting of certain exotics (pines), and the whole of the arrangements necessary to a complete reforestation of the area are now being pushed on in accordance with a carefully thought out working plan. These activities include roadmaking, a nursery for seedlings, arrangements for the clearing off of dead timber and of trees which for one reason or other—mostly fire—will never produce merchantable timber.

The Mundaring Catchment Area comes under the operation of Working Plan No. 1, which in general terms may be defined as the whole of the prime jarrah belt north of the Serpentine River, and contains approximately 400,000 acres. In order to facilitate the work, the area has been subdivided into blocks of workable dimensions, and the preliminary operations are being proceeded with.

The Electrification of Railways.

A Western Australian Timber's Unique Position.

That Western Australia in due time will follow the lead given by America, Great Britain, and certain of the Eastern States in the transformation of the railway motive power from steam to electricity can scarcely be denied. The advantages of the latter form of power are too obvious to call for recapitulation. If British experiences can be taken as a guide, this State has in its principal commercial timber a substance of unique value in electrical work. Jarrah has been used almost exclusively on English electric railways in connection with trolly-cables, but it has remained for recent experiments to demonstrate the fact that no other material except jarrah seems to be entirely satisfactory. Some time ago it was determined to fit up a section of the Lancashire and Yorkshire Railway with all-metal cars and all-metal appliances of every description. Had the idea been carried to successful accomplishment, jarrah would, of course, have found no place it that all-metal section, but it would seem that the engineer in charge has not been able to carry his all-metal intention out with that completeness which he had hoped for.

Mr. George Hughes, M.Inst.C.E., in a report upon the matter, writes as follows :—

> *Trolly-Cable.*—Naturally the designer was extremely anxious that it should be an "all-metal" car in every sense of the term, therefore the question of housing the trolly-cable gave rise to considerable investigation, and every endeavour was made to find a substitute for jarrah timber, which had been used for some years quite successfully on the Liverpool-Southport 600-volt section of the Lancashire and Yorkshire Railway. Exhaustive tests had been made in 1909 upon prepared samples of kauri-wood, jarrah, oak (untreated as well as treated with alum and copper sulphate), iron pipes, fireproof cables, concrete, Canadian redwood, uralite-asbestion and wych elm, with a view of approximating to working conditions and breaking down the material experimented upon with current up to 1,000 amperes at 600 volts; the object being to ascertain, the arc once started, which design and which material resisted and damped the arc in the most successful way, and with the least damage to the surrounding structure.
>
> It was found that jarrah fulfilled all the conditions most successfully; nevertheless, when the all-metal car was being designed, further considerable investigations were undertaken to find a substitute for jarrah, but without success; therefore jarrah was used. It is an additional insulation, it will not burn with a flame, and it smothers an arc when formed.

Writing on the same subject, Mr. Francis E. Gobey, O.B.E., Assoc. M.Inst.C.E., adds his testimony to what Mr. Hughes has said. Mr. Gobey reports that—

> Some experiments which had for their object to find the most suitable material for cable-troughing for electric railway cars, with an arc of 1,000 amperes from a 600-volt third rail, resulted in jarrah being proved practically non-inflammable, and it has been very successfully adopted for cable-troughing.

It would seem from the result of these English experiments that the future holds big and unique opportunities for jarrah in electrical railway engineering.

Advantages of Timber over Metal.

It is not here suggested that timber ought, for every purpose, take the place of metal. There are numerous conditions and positions which metal alone can satisfactorily fill ; equally there are many situations now occupied by metal to which wood might well be applied.

In constructional work timber has many advantages over metal. Among these are :—

1. Wood being an organic structure can be reproduced. Forests have been cut down at a greater rate than they have been regenerated yet, under a well-conceived forest management, forests can be made to yield indefinitely. With metal and stone the more extensively they are used the quicker the supply will become exhausted, and it is impossible to replace them.

2. Timber is stronger than is generally supposed. In tensile strength (resistance to a pull lengthwise of the grain) a bar of certain woods exceeds a similar bar of iron or steel of the same weight and height. A selected piece of yate timber resisted a stress of 19½ tons to the square inch.

3. Timber can stand a far greater distortion than metal without losing its power to regain its original position. In this way timber gives a warning before reaching breaking point.

4. Hardwood beams require prolonged intense heat to destroy their usefulness. The surface becomes charred and protects the inner portion. Timber beams will also remain in position after a fire and carry a load, while iron and steel beams will under the same heat bend, twist out of shape, and fall.

5. Timber does not corrode like metal. It lasts longer, even without paint, in exposed situations. With metal access to moist air must be prevented. Impurities in iron cause brittleness and weakness. Timber continuously under water lasts longer than iron or steel.

6. Timber is a poor conductor of heat and electricity, it is pleasant to touch, it is more artistic, and has a beauty absent from metal and has none of the injurious effects of iron and steel.

7. Pieces of wood may be strongly glued together ; metals, on the other hand, require welding or soldering, By too frequent reheating and forging wrought iron is weakened.

8. Certain timbers may be used for cask-making, and such casks are in every way preferable to metal. The elasticity of certain woods renders them superior to any metal for the resonant parts of musical instruments.

Sir T. G. Jackson, R.C., in his book "Reason in Architecture," 1906, page 171, says :—

> Iron construction is really still in an experimental stage; we do not yet know how it will stand the test of time. Meanwhile, all experience hitherto tends to show that an architect who wishes his building to go down to posterity will do wisely to let iron play as small a part as possible in its construction. It has been prophesied that 30 years hence no one will employ iron in his buildings, at all events as the main element in their fabric. The failure of a single tie-rod seems to have been the cause of the collapse of the roof at Charing Cross Station, and it is certain that no monster roof of that kind will ever be put up again. To say nothing of great railways and other engineering works, it is disquieting to think of the miles and miles of streets in London and other towns where the whole of the upper storeys rest on girders accessible to atmospheric changes, liable to rust and fatigue and possible injury by vibration, which no one can examine and which cannot be repainted.

Measuring the Height of a Tree.

A number of instruments or mechanical devices for ascertaining the height of objects are in use. Some of these are simple in construction and not difficult to use, while others require more or less technical skill for their adjustment.

The work may be done, however, without special appliances, and the following methods may be recommended :—Measure the length of the shadow of the tree, and also the shadow of a straight stick of known length, set perpendicularly in the earth ; multiply the length of the shadow of the tree by the length of the stick, and divide the product by the length of the shadow of the pole ; the result will be the height of the tree.

A method used when the sun is not shining is to set two sticks or poles in a line with the tree. From a point on one pole sight across the second pole to the base and to the top of the tree. Let someone note the points at which the lines of vision cross the second pole, and then measure the distance between these points. Also measure the distance between the sighting point on the first pole to the base of the tree and to the lowest vision point on the second pole. Multiply the distance between the upper and lower vision points on the second pole by the longer of the other two measurements, and divide by the shorter ; the result will be the height of the tree.

Another method sometimes used is as follows :—The observer walks a distance from the tree about equal to its estimated height ; he then lies on his back stretched out at full length, and an assistant notes on a vertical staff erected at his feet the exact point where his line of vision to the top of the tree crosses the staff. The height of this point from the ground is measured, and his own height from his feet to his eyes. Let AB be distance from observer's feet to his eyes, C the point on staff where his vision crosses, D the base, and E the top of the tree. Then—

$$AB : BC = AD : DE$$

or

$$DE = \frac{BC \times AD}{AB}$$

Example.—Let AB equal 6, BC equal 5, and AD equal 60, then $\frac{5 \times 60}{6} = 50$, the height.

Measuring the Volume of Trees or Logs.

Mensuration plays a very important part in scientific forestry and is the basis of all forest management. Organised forestry is essentially a business proposition and, consequently if it is to be run on sound lines, there must be regular periodic stock takings. To do this, the forester cannot handle his stock, but must measure an enormous number of trees standing. To facilitate such operations the trained forester calls higher mathematics to his aid and evolves yield tables, which show him the volume to be expected from a unit area of a certain class of country carrying a given species of tree ; form factor and volume tables assist him to calculate the volume of single trees. It is on such foundations as these that the whole science of forest valuation is built up.

No timber operations, however far removed they may be from forestry, are so haphazard that they do not require methods of arriving at the cubic contents of round mill logs. Unfortunately, rule of thumb methods have largely prevailed in the past. An Englishman called Hoppus published very many years ago an unsatisfactory system, which, unfortunately, was universally adopted in England and from there spread to Australia. To find the volume of a log, Mr. Hoppus suggested measuring the girth in the centre of the log and dividing by four, this he very logically called thc quarter girth, but to arrive at the volume he squared his quarter girth and multiplied by the length of the log.

$$i.e., \text{ volume} = \left\{\frac{\text{girth}}{4}\right\}^2 \times \text{ length.}$$

Realising that this was only a crude approximation of the true volume, it was claimed that it represented the actual timber obtained from the log when squared. As a matter of fact, the result obtained is 78½ per cent. of the true volume, while in Western Australia the recovery is less than 50 per cent.

A log, as everyone knows, is rarely a true cylinder. It tapers so that the butt end is larger than the top end. Consequently, it depends largely on the degree of accuracy required as to what method shall be employed in measuring. For ordinary work it usually suffices to measure the log in the centre, and calculate the area of the section at that point and multiply it by the length.

$$\text{\textit{i.e.}, volume} = \left\{ \frac{\text{diameter}}{2} \right\}^2 \times 3\cdot14 \times \text{length}$$

$$\text{or } = \frac{(\text{girth})^2}{4 \times 3\cdot14} \times \text{length.}$$

It is often more convenient to take the dimensions of the two ends instead of the centre ; in which case the volume is obtained by averaging the area of the two ends and multiplying by the length.

$$\text{\textit{i.e.}, volume} = \frac{\text{area of one end} \times \text{area of the other} \times \text{length}}{2}$$

It should be carefully noted that it does not suffice to average the two diameters or the two girths first, as the case may be, for a considerable error is thereby introduced. For those who prefer some simple method of arriving at the approximate contents of a log, the following rule may be recommended. Measure the girth in the centre, divide it by 5, square the result and multiply by the length. This gives one-half the true volume. Thus in order to arrive at the actual volume, the result must be doubled—

$$\text{\textit{i.e.},} = \left\{ \frac{\text{girth}}{5} \right\}^2 \times \text{length} \times 2$$

The Forests Department of Western Australia, in order to bring the practice in this State into line with that adopted in almost every country possessing timber forests, has prepared a table of contents in cubic feet of logs from 10ft. to 70ft. in length, and from 2ft. to 25ft. in mid-girth. This table gives the true contents of the log and its adoption is now rendered imperative by a regulation under the Forests Act of 1918.

Arbor Day.

The happy idea of setting aside a day for the planting of trees is American in origin. The day was first celebrated on 7th April, 1872, in Nebraska, U.S.A. Something over 30 years passed before the day was recognised in Australia, Victoria in 1909, it would seem, being the first to publicly proclaim a day to be known for all time as Arbor Day. Since then every State in the Commonwealth has given recognition to the day, more particularly as regards the schools. Arbor Day furnishes gratifying evidence that a forest-conscience is being aroused and stimulated in Australia. The day testifies to a new-found belief that forest conservation is a national duty. In Western Australia Arbor Day has received legal recognition and constitution. Clause 72 of the Forest Act reads, as follows :—

> One day shall be set apart in every year for the planting of trees in the several land divisions of the State, and such day shall be called "Arbor Day."

The Education Department, with a fitting sense of the importance of trees to the community, encourages the planting of trees in school grounds. By so doing the children acquire some knowledge of tree-growth, while the part that trees play in the life of a people is impressed upon them by their teachers. There is a wide field in Western Australia for worthy endeavour in this direction. In many parts of the State the hand of the vandal has destroyed every tree, and the roads are, in consequence, bare, shelterless and uninviting. Such roads should certainly be planted with suitable trees. By way of assisting in the good work, the Forest Department is prepared to supply, at cost price, young trees for planting in any suitable places throughout the State. But there are other cogent reasons besides beautifying landscapes and road vistas why the planting of trees should be seriously and systematically attended to. It is open to doubt whether there is any other matter which can approach in importance in Western Australia that of tree-planting and forest preservation. If our forests disappear, or the full volume of tree life is not kept up by steady planting, the water supply will be gravely affected, our hillsides will become bare rocks, our alluvial lands will lack moisture and cease to produce as they ought, rains will produce floods, springs will dry up or yield but slightly. It was upon recognition of these baneful results following denudation of trees, without planting, that led in Nebraska to the inauguration of Arbor Day.

So far as tree-planting by public bodies and landowners is concerned, there are numerous advantages attending the system of using healthy seedlings instead of raising them from seeds. But with schools the case is entirely different, for valuable cultural lessons are to be learned from watching the process of preparing the ground to the nurture of the infant seedling. Summarised, these advantages may be put thus :—

(a) The cost is less ;

(b) Varieties especially suited to the district may be obtained ;

(c) The trees when ready for planting out are acclimatised ; .

(d) The time which must elapse between the removal of the plant from its pot or bed to the permanent place of planting is very much shorter, and the tree consequently suffers less check ;

(e) It is possible to sow some seeds in the positions where the trees are to remain, and so to avoid the necessity for transplanting ;

(f) The most suitable time for planting may be chosen ;

(g) Greater interest is taken by the children in trees they have raised from seed ;

(h) The educational value of the work is far greater, and the practice of tree-raising and tree-planting is more likely to spread from the school to the children's homes.

Forestry in Schools.

Arbor Day—now a recognised school holiday in the majority of of the Australian States, and proclaimed in the Forests Act, 1918, as a day " set apart in every year for the planting of trees in the several land divisions of the State "—has done something to bring the great questions of tree protection and tree-planting before school children, but much yet remains to be done. Arbor Day has mainly to do with the planting and care of ornamental and shade trees, and this is an entirely different matter from the care of forests. The forester grows the tree to be harvested for its timber, or bark, or oil ; the landscape gardener or arboriculturist grows it for its shade, its beauty, or its ornamental value. The forests of all Australia have been sadly misused in the past. They have been exploited to an extent which has seriously impaired their value as a national asset, but, because an actual shortage has not made itself felt, the gravity of the position thus created has not been realised. Efforts are being made to impart a clear understanding of the situation to adult minds, but so far nothing of value has been attempted to instruct school children regarding a public question which intimately concerns their future. The creation in the schools of an active sentiment towards the planting and preservation of trees is urgently needed. There are no lessons that impress themselves so thoroughly upon the mind of humanity as those learned in the school room ; there is no period at which the receptive faculties are keener than in the time given to early study, and it is in these years that an intelligent sentiment towards forests and their meaning should be fostered. Responsibility in this direction certainly rests with the governing authority.

In forestry, as in other matters, the State's duty is to conserve the public assets, and it can best carry out its obligations and assert its authority in the way of protecting the interests of the community and of the future against the ill-advised use of national property by educational methods. Persuasive measures and restriction by legal methods can do something, but education is a much more powerful weapon for good, for when the people are convinced that the protection of forests is a matter vital to their own interests, they will willingly exert themselves in support of measures for preservation. And nowhere better than in schools can these fundamental principles as to the functions of government be learned and profited by.

It is not here suggested that school children should receive instruction in forestry to a degree and in the manner in which it is imparted in an institution specially designed for the training of men who intend to make forestry their life calling. Such a policy, even if possible, would be unwise and unnecessary. The course of forestry lessons in a State or other primary school would be confined to simple studies of the life history of a tree, with special reference to the trees of this State. Each of the principal trees in the forests of Western Australia would be described with illustrations and specimens of timber, bark, fruits, and leaves, wherever possible. The differences in species and varieties would be pointed out, and the pupils would be told what commercial purposes were served by each particular tree. One object of the lessons would be to enable the pupils to know the various trees in the forests and their uses, and attention would be also directed to the soil and climatic conditions which are best suited to the various trees. Another and equally important object would be to impart information as to the value of trees to a country, including such matters as the effect of woodland areas upon climate and stream and spring flow.

Incidentally, the value of trees to individual residents in country districts would be mentioned ; touching upon the growing of certain wattles for the profits to be reaped from their barks, the planting of trees on areas unsuited for the usual agricultural crops, as well as the growing of trees on such areas for shade for stock, and for sale at maturity, as has been done in the farming sections of the United States and Canada for many years. The teaching, from the nature of the circumstances, would be largely elementary, but it would be sufficient to arouse interest in tree life and to impress upon the scholars that trees are so important to the well-being of the people of a country that their planting and preservation is both a public and a private duty. As a branch of Nature Study, forestry has a special advantage, for it concerns itself with the imparting of knowledge of practical value in the every-day concerns of life. And in a State like Western Australia, where the forests play a prime part in the economic well-being of the country, it is in the public interest that its citizens should early be instructed in tree-lore, and in the economic truths which dictate the necessity for the preservation and protection of forests and for their wise utilisation.

Nor'-West Timber Resources.

It has been complained, with justice, by pioneers of the Nor'-West, that the authorities in Perth systematically neglect the vast area of the State lying to the North of the Tropic of Capricorn. This complaint has, there can be no doubt, a good deal of foundation in solid fact. Take timber for example. While the South-West timber areas have been surveyed with satisfactory minuteness, and their contents ascertained to a degree which enables us to estimate their value, the timber resources of the Nor'-West are still an unknown quantity. It is true that several expeditions, some official, and some the outcome of private enterprise, have traversed our tropic country and reported at more or less length on what they saw. But in no case has special attention been given to forests and forest products, and in nearly all cases where these are mentioned the information is fragmentary and contradictory. Here are two examples in point. Some years ago an enterprising citizen considered that he could make a good thing out of the Nor'-West forests, and, if his story accurately represents the facts, it certainly seems that he was in a fair way to do well.

This gentleman seemed to have formed a high opinion of the timber possibilities in the area he proposed to operate in. It is reported of this area that it was "approximately 20 miles by 12 miles of almost solid forest," and outside this again there were said to be isolated patches of a fair extent carrying good timber, but nothing consolidated. This forest, it may be mentioned, extended Eastwards to the border of the Northern Territory. It was estimated that the area in question would cut from three to four loads of timber per acre, but portions of the area seen by the reporter would, in his opinion, have cut fully double that amount. One sentence from his report is of some interest. "The class of timber is generally known as Cypress Pine (*callitris robusta*) and grows in large areas to a height of from 60 to 70 feet, with a diameter of from 6 to 30 inches." The document already quoted goes on to say "There are immense patches of young plants growing very thickly, and all through the forest are numerous young trees which will take the place of any grown timber cut, so even if this area is worked it would almost be impossible to destroy the forest, provided the young timber is by some means protected. There are also other valuable timbers in this locality, namely, Cadjeput and Messmate, which grow to a great size."

At a later date another prospective exploiter seemed to have stumbled on the same strip of country, and he writes about it in these terms :—

> I say without fear of contradiction that any man who says that he can find sticks there 60ft. long and 3ft. through is mistaken. In fact, to get a tree 60ft. at all, which I doubt, you would have to take the tree from the ground to the very topmost leaf. It was the most disappointing thing that I have ever been sent to look at in my life.

An official report by Mr. Despeissis, formerly Commissioner for Tropical Agriculture, refers to these pines in the following terms :—

> These forests will form an asset of no mean value in Northern Kimberley whenever some means are provided for getting the timber from the forests to ship side. The continuous fringe of swampy country, thickly lined with mangroves, and the swift tides rising and falling 22 to 32 feet which race up and down the long inlets which cut into the coast-line, will make transport a difficult and onerous undertaking.
>
> These pines generally grow in clumps, and at several places into forests of fair extent, one of which, and the largest yet reported, is located near Elephant Hill, some 40 odd miles North-east from Wyndham, and running in the direction of the Northern Territory border. Other cypress pine forests are also reported to exist in the direction of Yampi Sound, while Mr. F. S. Brockman also reports its presence through the country he traversed on the upper table-land of North Kimberley. This would show that the geographical distribution of this valuable pine would cover a coast length of 500 to 600 miles.
>
> The cypress pine grows on high sandstone ridges and tablelands, and follows sandstone spurs almost down to the coast. Its market value is said to be about twice that of jarrah, and it can be milled with less waste. The timber, which is highly impregnated with turpentine and resinous matters, is never attacked by white ants, or, it is said, by the teredo borer in sea water. For these reasons it should be a valuable timber to conserve for use within the tropics where imported timber is very costly. It has been suggested that the Government reserve these for the use of fruit-growers of the South-West. Such a suggestion, however, can only be born of ignorance regarding the timber, which is one of the most unsuitable for the purpose on account of highly scented resins it contains.
>
> Should it be found practicable to open up and exploit these cypress pine forests, the erection of sawmills through that country would not only prove a source of wealth to the State but would offer one of the best means of gaining a better idea of the coastline of Kimberley and of pushing settlement into the heart of a rich country, now occupied by some thousands of treacherous blacks.

But there is evidence from official and private sources that outside of cypress pine there are other valuable timbers in the Nor'-West. Messmate, for instance, and that variety of eucalypt known as Coolibah. The former has many of the qualities of York gum, and the latter is probably the hardest timber on this continent. Although not a large tree, the Coolibah can be utilised wherever density and endurance are required. Again, tan barks, of which the world is always in need, are to be found in the Nor'-West. One of these, ridge gum, upon analysis has been found to contain over 30 per cent. of tannin, a proportion which places it in the front rank of tanning materials.

What exactly the Nor'-West contains in the matter of forest resources will not be ascertained until a systematic timber survey has been made, and this is a duty which the Government must undertake at an early date.

Big Trees in Western Australia.

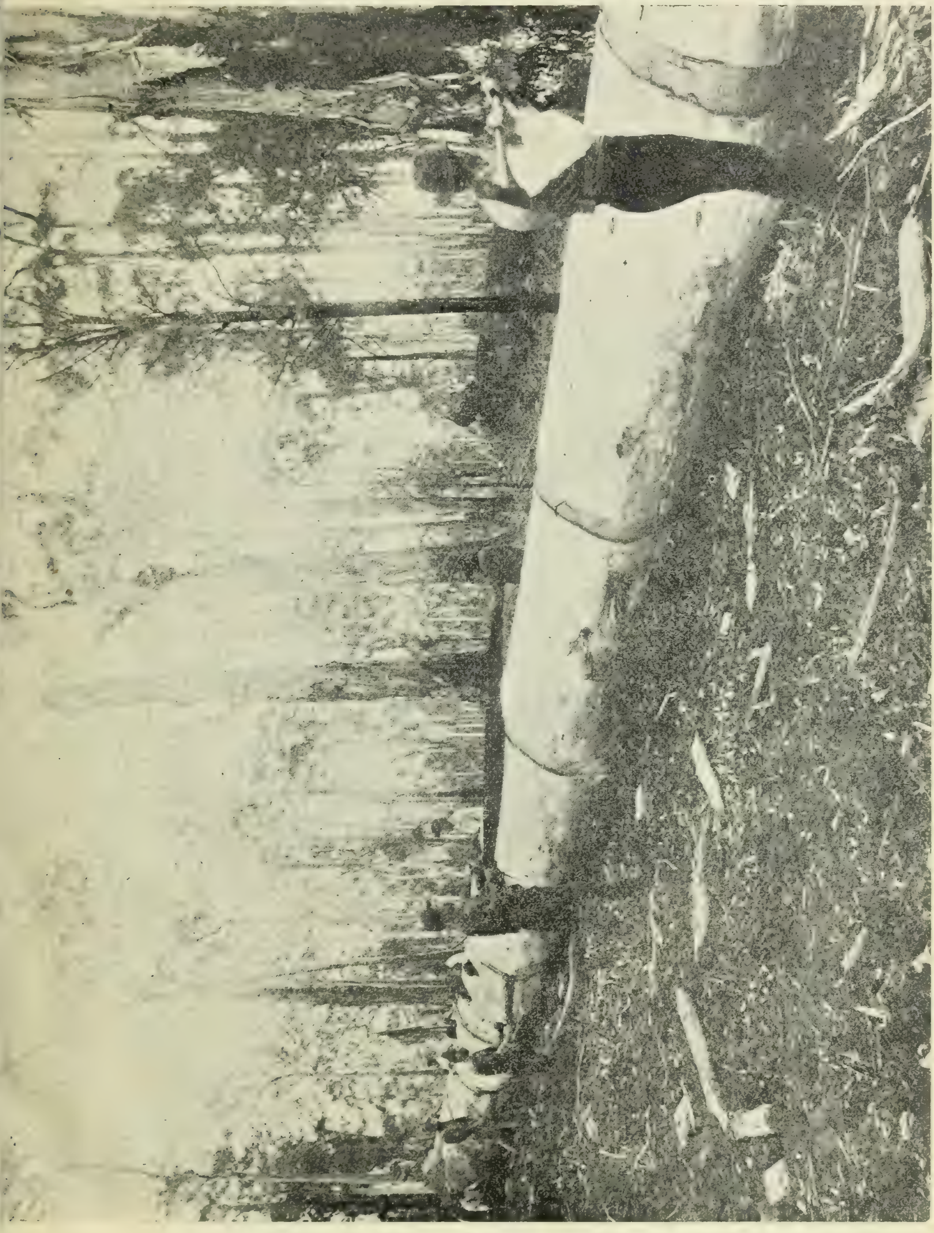
All of the native trees of the State furnishing merchantable timber are large in size compared, say, with the native trees of Europe. The average karri tree in height and yield of timber is equal to any found in the Commonwealth. When what remains of the present over-mature crop of jarrah and karri has been cut down, it is unlikely that specimens equal in bulk to what the forests have already yielded or still possess will be seen by future generations. When the State's forests have become "cultivated," trees will be cut when they reach maturity. Sentiment may dictate the preservation of a few for a period far beyond that of maturity, as reminders of the giants of former days, but whole forests of giant trees will no longer be seen. An official travelling overland in 1840 from Perth to King George Sound describes the karri he saw as "monsters whose size is almost incredible," and he mentions one which had fallen as being "over 400 feet in length and over 300 feet to the first branch." These figures are the traveller's estimates, and it is possible that exact measurements might have reduced them somewhat. Many accurately measured instances testify to the huge proportions to which karri may attain. The height of karri taken on an average may be put down as slightly over 200 feet, with a barrel from 120 to 150 feet to the first limb, and a diameter three feet from the ground of from four to five feet. But very many specimens exceed these averages. Mr. J. Ednie Brown, at one time Conservator of Forests of Western Australia, measured one at Karridale and gave the following figures as its dimensions :—

34 feet in circumference at three feet from the ground ;
160 feet to the first limb ;
14 feet in circumference at the first limb ;
Over 200 feet in extreme height.

From these figures it may be ascertained that the bole of the tree from the bottom to the first limb contained nearly 6,000 cubic feet of timber, weighing over 40 tons. The karri is a tree of comparatively rapid growth. In illustration of this Mr. Ednie Brown gave the following particulars of a specimen grown on the road from Giblett's to the Vasse :—

Height of whole tree—153 feet ;
Height to top of available timber—100 feet ;
Thickness of bark—half-inch ;
Diameter at two feet seven inches from ground—one foot eleven and a-half inches ;
Age of tree by concentric rings—Thirty-five years.

"It is a matter of local record," continued Mr. Ednie Brown, "that a resident on the Warren lived and raised his family in a hollow of one of these fallen monsters. This specimen was said to be over 300 feet in height and some 12 feet in diameter at the base."



Cross-cutting a Karri Log.

More recently a karri tree was measured in the National Park, along the Vasse and Warren road, and the following are the figures:—

Height to first limb—159 feet ;
Total height, 269 feet ;
Girth at 4 feet 3 inches from ground—17 feet 8 inches ;
Estimated middle girth—14 feet ;
Estimated timber contained in bole—50 loads.

The present Conservator of Forests measured a karri tree on the head waters of the Donnelly 278 feet high, and he expects to find one over 300 feet high.

Jarrah also exhibits some specimens of unusual size. Cases are on record of individual trees of which the measurements run into figures far in excess of the average. One tree of abnormal size was found about three miles West of the old Wellington mill on the Ferguson River, measuring 22 feet in circumference at five feet up from the ground, and 80 feet to the first branch. Another large specimen on the Ferguson area went 21 feet in circumference at four feet from the ground, and 75 feet to the first branch.

Tuart often attains a height of 150 feet and a diameter of 22 feet at the base. In some cases the trees run up 70 or 80 feet to the first branch. It is on record that a huge specimen was felled in order to provide a board to send to the Great Exhibition in London in 1852. It was expected that a board 12 feet wide would have been got out of this tree, but no saw was to be found capable of dealing with the log, so the project fell through.

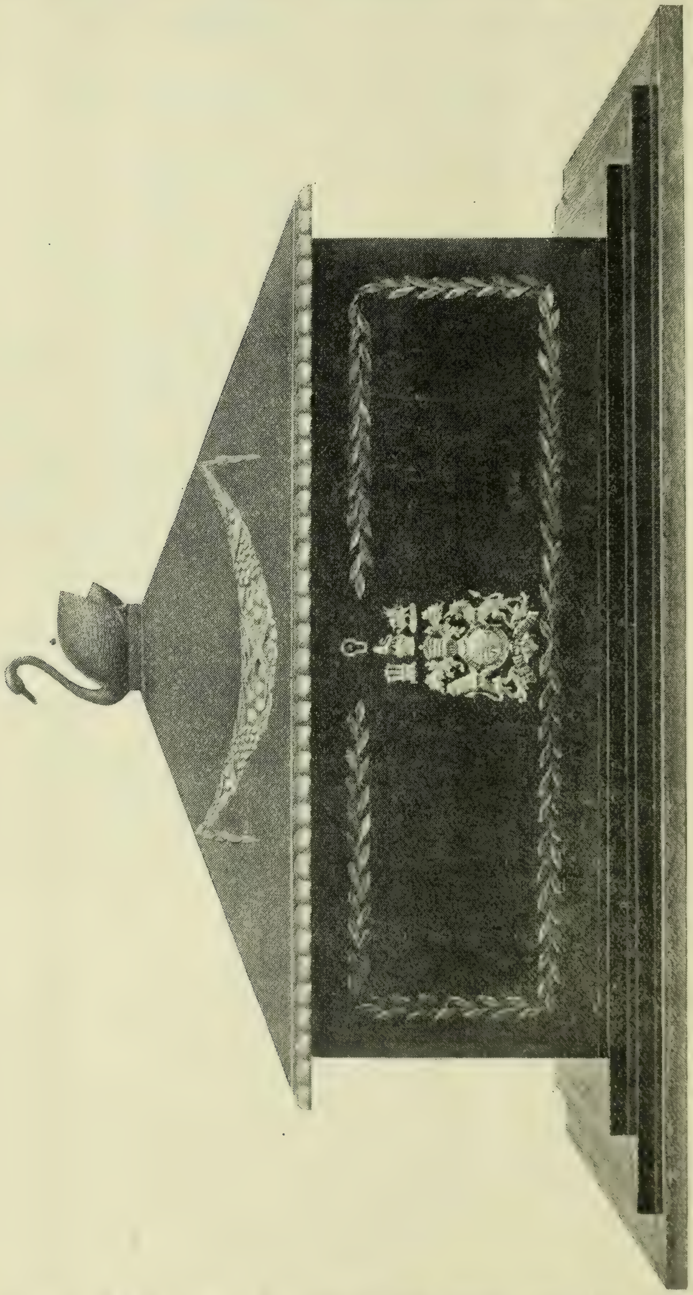
A Souvenir Casket of Western Australian Timbers.

PRESENTED TO H.R.H. THE PRINCE OF WALES.

By way of furnishing His Royal Highness the Prince of Wales with a memento of his visit to this State, the Government prepared a casket representative of the principal natural resources of the country. The matter was put, by the Minister for Forests, into the hands of Mr. C. E. Lane-Poole, the Conservator, and the result was that a souvenir of unique beauty and fully representative was prepared. It was presented to his Royal Highness at a State Banquet given at Government House. The casket is an exceptionally beautiful piece of work and one worthy of Western Australia, the measurements being 13in. long x 8in. wide x 10in. high. The foundation is of river banksia, on which has been laid a veneer of beautifully figured curly jarrah. The inlay is sandalwood, and the plinths on which it is raised are native pear, raspberry jam, and river banksia. The inside of the box is grooved and fitted with specially picked thin samples of West Australian timbers. The various industries of the State are represented on the casket. On the lid are four conventional wreaths of fruit inlaid and carved in sandalwood, representing the fruit industry. At one end is the Western Australian Government coat of arms, with its motto "Cygnis Insignis" beneath. This in itself is a work of art, and how wonderful the carving is can only be appreciated by a minute examination of the work. On the opposite end our wheat and wool industries are decoratively treated, while round the entire box runs a wreath of inlaid leaves in sandalwood. The contrast between the pale sandalwood and the rich colour of the jarrah is most charming.

The golden wealth of the State is well represented, for in the front of the casket is an exact reproduction in gold of H.R.H.'s coat of arms, with its ornamental Welsh dragon, three feathers, the lions, and his motto "Ich Dien." Heavy ornamental gold hinges of decoratively treated gum blossoms and leaves are placed on the back, and the golden key, perhaps the most attractive part of the whole, represents both the fisheries and pearling industries. The two magnificent pearls held between the fish were presented by the Pearlers' Association of Broome, and two more perfect gems could not be desired. Surmounting the casket is a black swan made of North-West ebony obtained from the Broome district. The containing box is of plain polished banksia. The casket was designed by Mrs. C. E. Lane-Poole, the timber and part of the expense of the workmanship were given by the Sawmillers'

Association and the woodwork was executed by Messrs. Robertson and Moffat's Successors, the carver, to whom special recognition is due, being Mr. Ambler. The gold was presented by the Chamber of Mines,



Casket of W.A. Woods.

Presented to H.R.H. the Prince of Wales during his visit to W.A.

Kalgoorlie, while the gold work was most satisfactorily carried out, by Messrs. Caris Bros. The casket is a very fine example of the capabilities of our principal timbers for decorative and artistic purposes.

Notes of Interest.

Blackboy gum, in the days when ship and boat building was an industry of the first importance in Western Australia, was much employed by ship and boat builders. By mixing it with Stockholm or coal tar a very satisfactory "pitch" was obtained.

The first steam sawmill in Western Australia was erected in Guildford, and the first regular yard for the sale of sawn and other timber was kept by Mr. Monger, and situated under Mount Eliza.

For the first 30 years of the Colony of Western Australia jarrah was colloquially termed "mahogany," and was exported under that name.

The sandalwood industry of Western Australia has had many vicissitudes. Sometimes the price has been high, and exporters and cutters have done remarkably well; at other times the market rate in the East has been so low that it did not pay to export the wood. It is on record that one shipment to Singapore brought only 2s. 1d. per picul (133⅓lbs.)

Some of the early colonists, with memories of the beauty and usefulness of the English oak, and apparently with but limited faith in the capabilities of the land of their adoption, determined to culitvate in Western Australia the oak of their homeland. So, within five years of the foundation of the Colony, Mr. J. Drummond, the Government Botanist, was notifying the public that seedlings of English oak were for sale at a low rate at the Botanic Gardens, Perth, and the cultivation of these trees was strongly recommended to settlers. The absence of groves of English oak to-day is probably due to the fact that Mr. Drummond's invitation was not widely responded to, probably because the great majority of the people had discovered that the local timbers were equally as serviceable.

Writing in 1884 of the Hamelin Timber Station, Mr. J. Harris, Inspector of Forests, says, "The mill-beach railway remains in excellent repair, and the karri wood rails show but very little signs of wear and tear. The steep gradients are now protected with steel plates, which have greatly contributed to make the line safe and useful."

The Quindalup Station, writes Mr. Harris, was the first established in the Colony, Mr. Yelverton, senior, having commenced cutting at

Quindalup about 30 years since, and during the period several hundreds of cargoes have been shipped. Mr. Yelverton has made many substantial improvements in the machinery. The vertical saw is much improved, and is worked by two men, as at Karridale. In 1884, at Quindalup, the cost of production of sawn timber, f.o.b., was about 20s. per load, hewn square, from 40s. to 50s. per load, and round piles, about 9d. per foot.

At Karridale, in 1884, the men in the mill, on the tramways, and at the Hamelin worked not less than 10 hours per day. Wages of the men varied from 6s. to 12s. a day, boys as high as 4s. a day.

In his report for 1886 Mr. Harris wrote, "The men are ready for their work at the mills before the dawn of day, and, with the exception of an hour for dinner, are employed till sundown. Extra wages are given to men willing to work after hours."

A useful Tree.

An early reverend visitor to Western Australia, the Rev. G. G. Nicolay, gives the following quaint description of a tree he found :—

> The vegetation of the North is, of course, tropical, and has its own peculiar characteristics. Of these the gouty-stemmed tree, like other Adansonias, and the Barriguda of Brazil, is remarkable for the swelling of its trunk, giving it a clumsy, deformed appearance, yet it is valuable as affording fruit about the size of a cocoa-nut, the seeds enclosed in which, closely resembling almonds, are very palatable and commonly used by the natives for food; the bark yields a nutritious white gum which, Grey says, in taste and appearance resembles macaroni, and which, when soaked in hot water, affords an agreeable mucilaginous drink.

Later visitors do not share the reverend gentleman's appreciation of the wide range of usefulness to which the tree may be put, but they note that the "agreeable mucilaginous drink," when fermented, produces an intoxicant of no mean power.

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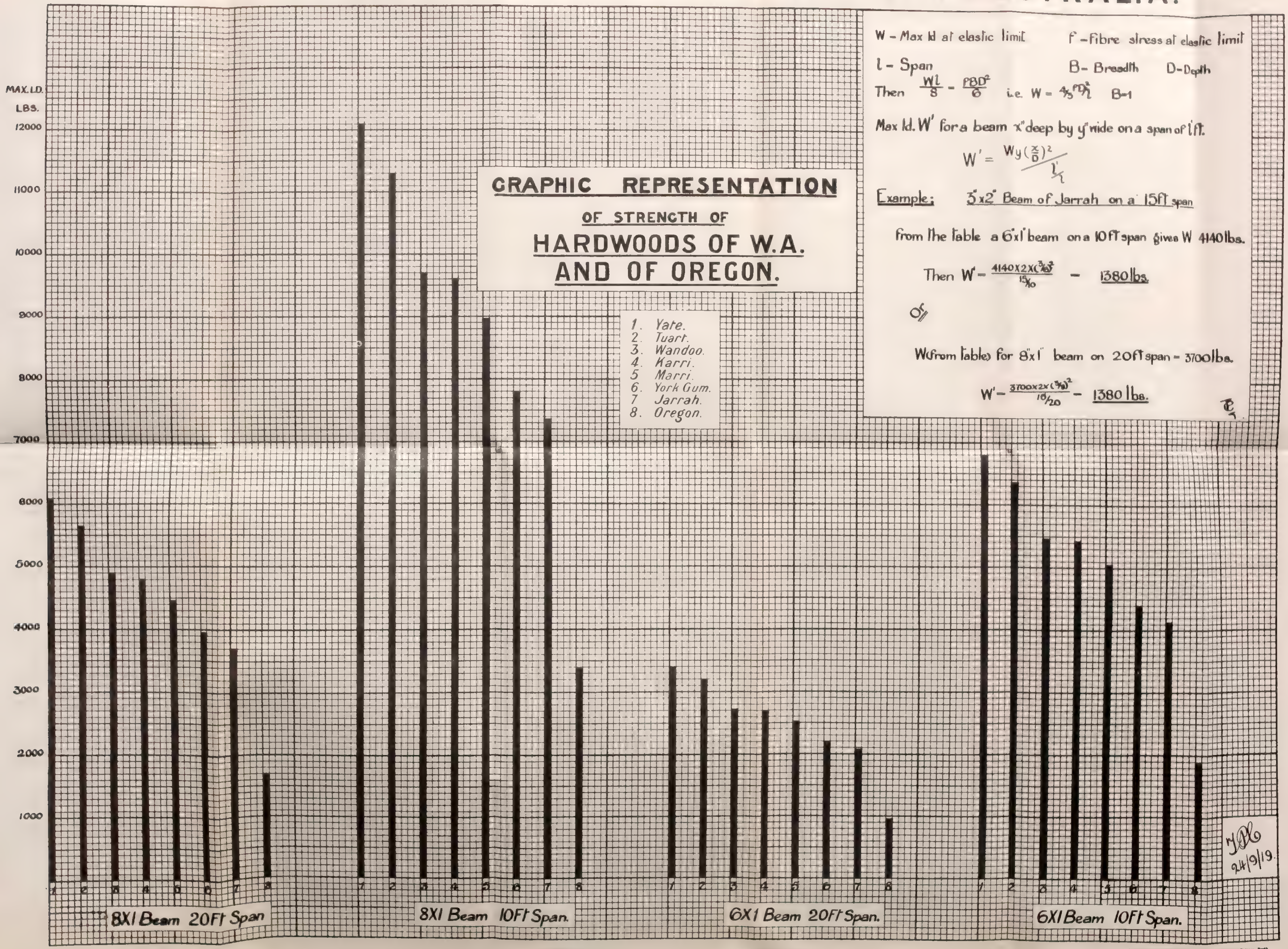
FORESTS DEPARTMENT PERTH, WESTERN AUSTRALIA.



GRAPHIC REPRESENTATION
OF STRENGTH OF
HARDWOODS OF W.A. AND OF OREGON.

W – Max ld at elastic limit f – Fibre stress at elastic limit

l – Span B – Breadth D – Depth

Then $\frac{Wl}{8} - \frac{fBD^2}{6}$ i.e. $W = \frac{4}{3}\frac{fD^2}{l}$ $B=1$

Max ld. W′ for a beam x″ deep by y″ wide on a span of l′ ft.

$$W' = \frac{Wy\left(\frac{x}{D}\right)^2}{l'/l}$$

Example; 3″x2″ Beam of Jarrah on a 15ft span

from the table a 6″x1″ beam on a 10ft span gives W 4140 lbs.

Then $W' - \frac{4140 \times 2 \times (3/6)^2}{15/10}$ – 1380 lbs.

or

W (from table) for 8″x1″ beam on 20ft span – 3700 lbs.

$W' - \frac{3700 \times 2 \times (3/8)^2}{15/20}$ – 1380 lbs.

24/9/19.

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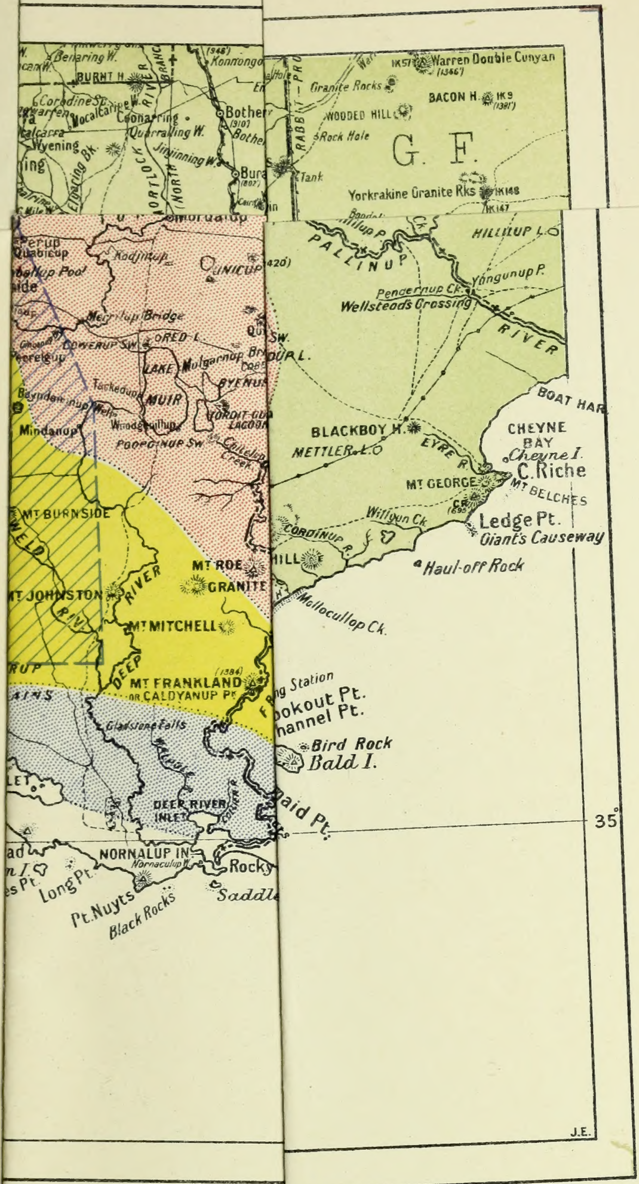

Berlaring W.
BURNT H.
Kojonup River
Konnongo
Bothe
Bothe
Bur
Cordine Sp.
Wocalcarine W.
Coonarring
Quarralling W.
Jinjinning W.
Wyening
Lipstoring Bk.
Mortlock
North Branch
Rabbit-Proof Fence
Granite Rocks
Warren Double Cunyan
(1566')
BACON H.
IK9
(1381')
WOODED HILL
Rock Hole
G. F.
Tank
Yorkrakine Granite Rks
IK148
IK147
HILLILUP L.
PALLINUP
Yongunup P.
Pendernup Ck.
Wellstead's Crossing
RIVER
BOAT HAR
CHEYNE BAY
Cheyne I.
C. Riche
MT BELCHES
BLACKBOY H.
METTLER L.
EYRE R
MT GEORGE
(895')
Willyun Ck
Ledge Pt.
Giant's Causeway
CORDINUP R.
Haul-off Rock
Mellocullop Ck.
Perup
Quabicup
Kodjinup
QUINICUP
(420')
Mordalup
Mercilup Bridge
CORED L.
Cowerup Sw.
LAKE MUIR
Mulgarnup
BYENUP
Tackedup
Beyndenup
Pereteup
Mindanup
Woodgillup
POORGINUP SW.
TOROIT-GUP LAGOON
Cattelup Creek
MT BURNSIDE
WELD R.
MT JOHNSTON
DEEP RIVER
MT ROE
GRANITE
HILL
MT MITCHELL
MT FRANKLAND OR CALDYANUP PK
(1384')
Gladstone Falls
DEER RIVER INLET
NORNALUP IN.
Nornaculup
Rocky
Saddle
Long Pt.
Pt. Nuyts
Black Rocks
Station
Lookout Pt.
Channel Pt.
Bird Rock
Bald I.
Maid Pt.
35°
J.E.

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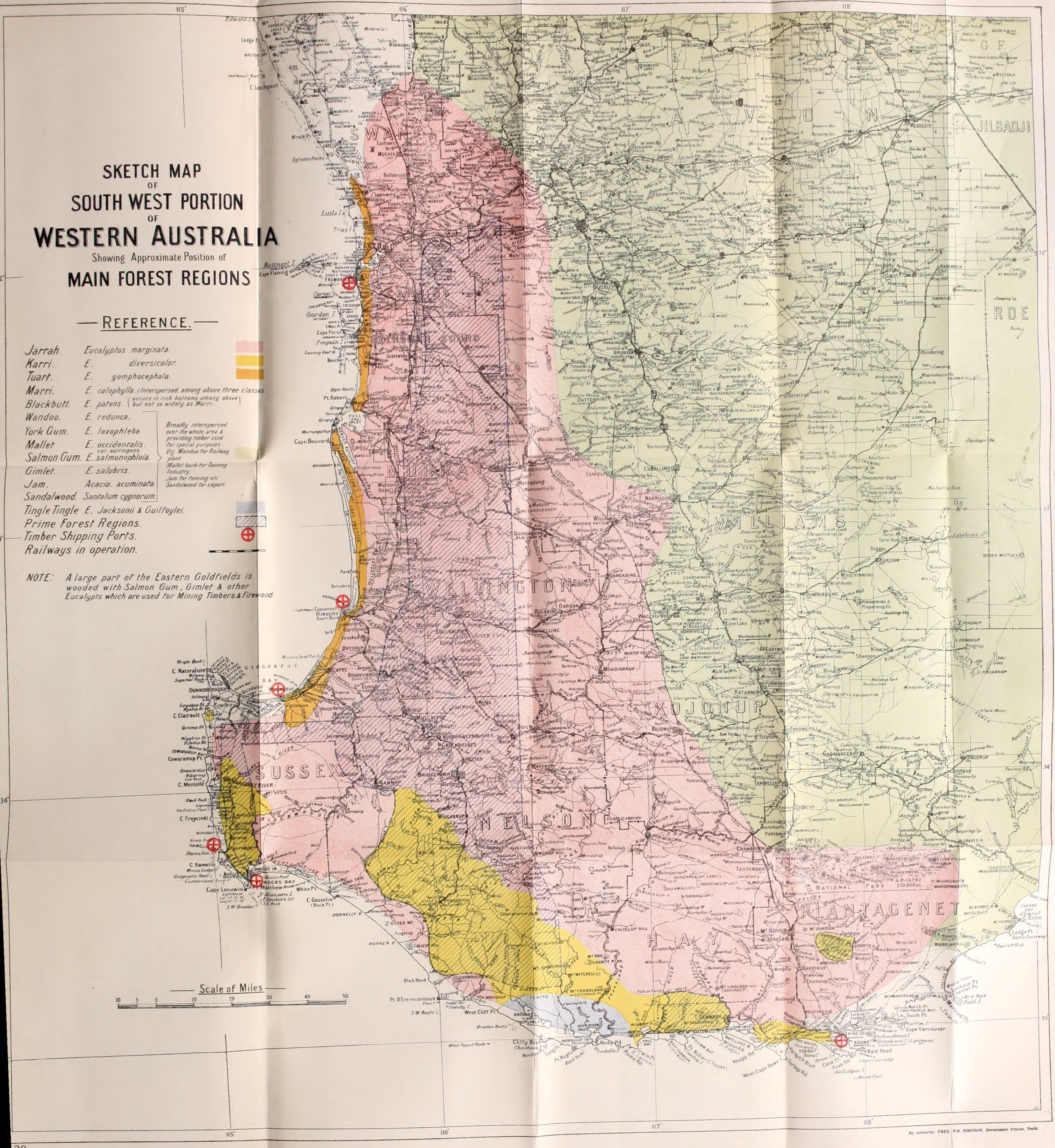

SKETCH MAP
OF
SOUTH WEST PORTION
OF
WESTERN AUSTRALIA
Showing Approximate Position of
MAIN FOREST REGIONS

— REFERENCE. —
Jarrah. Eucalyptus marginata. ▨
Karri. E. diversicolor. 🟨
Tuart. E. gomphocephala. 🟧
Marri. E. calophylla. (Interspersed among above three classes.
Blackbutt. E. patens. {occurs in rich bottoms among above but not so widely as Marri.}
Wandoo. E. redunca.
York Gum. E. loxophleba.
Mallet E. occidentalis. var. astringens.
Salmon Gum. E. salmonophloia.
Gimlet. E. salubris.
Jam. Acacia. acuminata.
Sandalwood. Santalum cygnorum.
Broadly interspersed over the whole area & providing timber used for special purposes Viz. Wandoo for Railway plant. Mallet bark for Tanning Industry. Jam for fencing etc. Sandalwood for export.
Tingle Tingle E. Jacksonii & Guilfoylei.
Prime Forest Regions. ▨
Timber Shipping Ports. ⊕
Railways in operation.
NOTE: A large part of the Eastern Goldfields is wooded with Salmon Gum, Gimlet & other Eucalypts which are used for Mining Timbers & Firewood.
Scale of Miles
10 5 0 10 20 30 40 50
115° 116° 117° 118°
32° 33° 34° 35°
SWAN
AVON
JILBADJI
ROE
WILLIAMS
WELLINGTON
MURRAY
KOJONUP
SUSSEX
NELSON
HAY
PLANTAGENET
GEOGRAPHE BAY
FREMANTLE
BUNBURY
Cape Leeuwin
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